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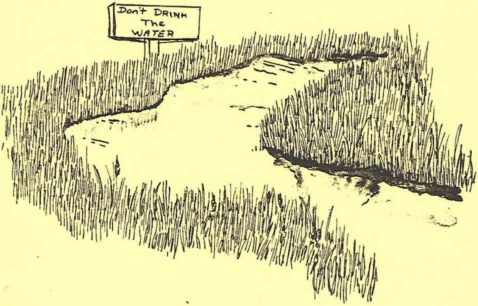
GREAT BASIN WATERSHED WORKSHOP



ELKO, NEVADA

NOVEMBER 5-8 1979

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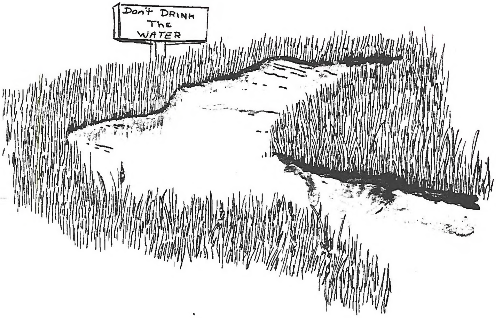

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"A New Decade of Progress Ahead"

Proceedings
of the

GREAT BASIN WATERSHED WORKSHOP

Elko, Nevada

November 5-8, 1979

Sponsored by: THE BUREAU OF LAND MANAGEMENT
Nevada, Utah, Idaho, Oregon

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3 1849

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Rangeland Resource Management and New Watershed Responsibilities -- Keith Miller, Asst. Chief, Director of Rangeland Management, W.O. - BLM, (Edited from notes)

The current rangeland policy under review is the first comprehensive policy since the 1960's. Comments are being accepted on the public review draft "Managing the Public Rangelands" until January 31, 1980.

The present range condition is much a result of the past century's abuse and continuation of ineffective policy. The key solution to the dilemma is proper management of the vegetation.

Objectives have to be met through grazing management. Such objectives include reduction in erosion hazard, minimizing impacts to livestock industry, improving habitat for wildlife, endangered species and improving riparian areas.

Requirements to obtain proper grazing management include inventory, Environmental Impact Statements, integrated plans, soil production data, water quality protection, endangered species protection, implementation of new systems, developing improvements and development of monitoring systems.

Outside involvement is vital to achieving objectives. Public involvement should be stressed, work with the National Government Association, stewardship program, scientific and academic community and the National Academy of Science.

Within the watershed program their exists a fractured situation. Such problems exist because of the nature of watershed and overlap into many areas including floodplains, riparian habitat, etc. Interdisciplinary input is necessary to solve the problems in these areas. Truly professional employees will not allow the organizational problems to interfere with their field work.

Question: The Fragmented Watershed Program - What will it accomplish?

A: Field shouldn't be concerned with reorganization in W.O. Should be concerned with field problems.

Question: What about the loss of technical staff in W.O.?

A. Staff will be centered in the W.O. Range staff for technical support.

- Policy in Water Policy staff.

Question: What kind of relationship with other agencies do we have concerning rangesites?

A: Task Force with basic agencies based in Ft. Collins Group in SCS is standardizing units.

Proposals of how we should handle our sites due soon.

Question: Will funding (4340) stay intact or will it loose identity?

A: Hope it will stay intact.

Question: Any changes in W.O. watershed program filtering down to S.O., D.O., etc.?

A: Wouldn't support any field level reorganization. No matter how we organize, we should be able to do the job.

Question: Any improvement in in-house professionalism?

A: No. Need faster way of doing things. Big problem with the high percentage of temporary employees.

Comment: Difficult to control the quality or know how the inventory was done under contract.

A: This may be the price we pay to show problem.

Question: When will everyone be doing the SVIM correctly?

A: When it is input into the computer. Everyone will be forced to play the game straight.

If data is sound - stay with decision. Don't buckle under to demands - in the long run, it will pay off.

BLM WATER POLICY

INCLUDING WATER RIGHTS

Ron Kuhlman - Water Resources Policy Leader, WO
(Edited from notes)

President Carter's water policy message instructed Federal agencies to work closely with the States in developing and acquiring water rights. The Department of Interior Solicitor issued an opinion asking for the Interior Agencies to work with the States.

Task Force 5A on non-Indian reserved water rights recently issued a draft statement urging Federal agencies to follow State law where appropriate. The Solicitor's opinion and the Task Force both support this cooperation, but stress that there are reserved rights that the BLM should be aware of which include public water holes and springs, stock driveways, abandoned oil and gas wells, mineral hot springs, wild and scenic areas and other special areas covered by Congressional action.

The result of a recent workshop between the BLM hydrologists and numerous solicitors identified the following statements: The physical and legal availability of water should be determined, State law should be followed where practicable, the Federal appropriative right appears to be a method for obtaining rights to water where State and Federal laws do not coincide, water permitting systems may be implemented by BLM and a National Water Policy should be developed.

Question: Does wildlife include fish?
Answer: Yes.

Question: How does one obtain an instream flow right?
Answer: Work with others (State, etc.), or use Federal appropriated water right, or purchase, or condemn.

Question: Is there a procedure for obtaining a Federal appropriate water right?
Answer: No, but I suppose you would have to work through solicitor, justify need for water, show necessity and consider condemnation.

RESULTS OF MAHOGANY CREEK WATERSHED STABILIZATION PRACTICES

Ted Angle, Watershed Specialist, Winnemucca DO, BLM,
Gene Dahlem,Fisheries Biologist, Winnemucca DO

The Mahogany Creek Rehabilitation Study is a grazing vs. non-grazing study on a 12,000 acre watershed near Winnemucca, Nevada. The presentation showed the results compiled from the study. For more information, contact the above authors at the Winnemucca District, 705 E. 4th St., Winnemucca, NV 89445, Com. 702-623-3676, FTS 598-6011.

CONDUCTING THE INVENTORY

MUCH OF THE DATA ARE GATHERED DIRECTLY BY MAPPING AND MEASUREMENT OF RELEVANT PARAMETERS. ON MOST WILDLAND WATERSHEDS, HOWEVER, THERE ARE CERTAIN DATA THAT CANNOT BE MEASURED DIRECTLY, AND MUST BE SYNTHESIZED ON THE BASIS OF KNOWN RELATIONSHIPS WITH CHARACTERISTICS THAT CAN BE MEASURED.

SOMETIMES, IT IS PHYSICALLY POSSIBLE TO OBTAIN DIRECT MEASUREMENTS, BUT IT IS NOT ECONOMICALLY FEASIBLE TO DO SO OR IT MIGHT TAKE TOO LONG. CLIMATIC AND HYDROLOGIC DATA FREQUENTLY FALL INTO THE LATTER CATEGORY - ESTIMATES ARE ESTABLISHED BY EXTRAPOLATION AND SYNTHESIS FROM KNOWN DATA.

PRESENTATION AT THE GREAT BASIN WATERSHED WORKSHOP, ELKO, NEVADA
BY RONNIE D. CLARK, NOVEMBER 5-8, 1979
DENVER SERVICE CENTER
DIVISION OF RESOURCE INVENTORY SYSTEMS

THE WATERSHED

FEATURE MAPPING

ILL. 35, PAGES 7, 8 & 9

A. TOPOGRAPHY & DRAINAGE SYSTEM

B. LAND FORMS & GEOLOGY

SOIL CONSIDERATIONS

C. SOILS

1. HYDROLOGIC DEPTH
2. PERMEABILITY AND INTERNAL DRAINAGE
3. SURFACE CHARACTERISTICS (INFILTRATION & ERODIBILITY)
4. MASS STABILITY
5. SOIL MECHANICS AND OTHER ENGINEERING CHARACTERISTICS

DETERMINATION OF EROSION CONDITION CLASS	D. CHANNEL CHARACTERISTICS - NETWORK, CAPACITY, NATURE OF BED, CONDITION (EROSION CLASSES) AND WATER (PERENNIAL OR EPHEMERAL)
	E. VEGETATION
	1. FOREST OR WOODLAND (INCLUDING UNSTOCKED)
FOREST LANDS INVENTORY	A. OVERSTORY - TYPE, DENSITY, AGE, QUALITY, HAZARDS, SUCCESSIONAL STATUS
VEG. CHARACTERIZATION	B. UNDERSTORY & LITTER - TYPE, DENSITY, AGE, GRAZING VALUE AND GROUND COVER
STEP POINT TRANSECT	1) TYPE (LITTER, VEGETATION, ROCK, BARE SOIL, ETC.
	2) DEPTH (LITTER)

2. RANGELAND

RANGE SITY DELINEATION	A. TYPES
VEG. CHARACTERIZATION	B. DENSITY (BY SPECIES OR RANGE TYPES)
WEIGHT EST. PLOT	C. PRODUCTIVITY (BY SPECIES OR RANGE TYPES)
VEGETATION CHARACTERIZATION	D. BROWSE OR GRAZING VALUES
CONDITION CLASS	E. CONDITION
STEP POINT TRANSECT	F. GROUND COVER
	1) TYPE (LITTER, GRASS, ROCK, BARE SOIL, ETC.
	2) DEPTH (LITTER)
ILL. 51	G. SEASON OF USE
.52 - SPECIAL HABITAT FEATURES	H. SPECIAL FEATURES

	F. WILDLIFE
ANIMAL SPECIES	1. KINDS AND AMOUNTS BY LOCATION
	2. HABITAT CONDITION
VEG. PRODUCTION & CHARACTERIZATION	A. FOOD - KIND, AMOUNT, & AVAILABILITY
	B. COVER - KIND, AMOUNT & DISPERSION
WATER	C. WATERS
	G. OTHER FACTORS
SOIL CONSIDERATION	1. GEOLOGIC FORMATIONS
-T/E OR LOCALLY ENDEMIC PLANTS	2. RARE PLANTS

SVIM INPUT	INTERPRETATIONS OF INVENTORY DATA
Combination of vegetation inventory, comparison areas and condition classification	1. Present condition rating and apparent trend: A. Present ecological condition and apparent trend - Plants and plant communities as indicators
Range Site Delineation	2. Indicators of conditions, processes, and uses A. Salt grass - water table near surface B. Greasewood - water table @ greater depth C. Mesquite - water table very deep

SOIL CONSIDERATION

MAPPING
SOIL FIELD INVENTORY PROCEDURES
VEGETATION FIELD
INVENTORY PROCEDURES

SOIL INVENTORY

VEG. FIELD INVENTORY
COMPARISON
SSF

3. INDICATORS OF SOIL TYPE

   A. HARD, COMPACT, VERY FINE SANDY - AND SILT-LOAM SOILS - SHORT GRASS DISCLIMAX - HIGH RUNOFF

   B. SANDY LOAM - TALL, DEEPLY ROOTED PLANTS - LIMITED RUNOFF

4. INDICATORS OF SALINITY - SALT TOLERANT VEGETATIVE SPECIES - FEW IN NUMBER OR COMPOSITION

   COMMUNITY BOUNDARIES ARE ABRUPT & DISTINCT

5. INDICATOR OF EROSION SUSCEPTIBILITY

6. INDICATORS OF EXCESSIVE USE OF COVER - OVERGRAZING, O.R.V., ETC.

	INVENTORY BARE SPOT PRONE AREAS COLONIZED BY WEEDS OR WEEDLIKE SPECIES - LAMBS QUARTER, TANSY MUSTARD, ANNUAL BROME GRASSES, PEPPERGRASS, SQUIRREL TAIL, CACTI -
SSF COMPARISON AREAS	7. PRESENT WATERSHED EROSION CONDITION AND APPARENT TRENT -
COMBINATION OF VEG. INVENTORY AND COMPARISON AREA SUBSECTIONS	8. ALLOCATION OF VEGETATION RESOURCES - BOTH PRESENT AND POTENTIAL (RESERVATION OF COVER)
VEG. INVENTORY, SOIL CONSIDERATIONS, AND COMPARISON AREA SUBSECTIONS	9. LAND TREATMENT POTENTIALS AND NEED FOR MANAGEMENT CHANGES
	10. PSIAC - SEDIMENT YIELD ESTIMATION
ILL. 33	A. SURFACE GEOLOGY
ILL. 33	B. SOILS
SSF	C. RUNOFF

Ill. 33	D. Topography
Step Point Transect	E. Ground Cover
Ill. 40	F. Land Use
SSF	G. Upland Erosion
SSF	H. Channel Erosion
	11. Universal Soil Loss Equation
	(A = R K L S C P)
SSF	A. R - Rainfall and runoff factor
Soil Inv.	B. K - Soil Erodibility factor
Base Maps	C. LS - Length and Steepness of slope effect
Step Point Transect and Comparison Area	D. C - Cover & Management factor
Watershed Comparison Areas	E. P - Supporting practice factor

(Note: Detailed inventory interpretations is not available from SVIM procedure for climate, surface flows, ground water hydrology, & several water quality parameters)

Soil Inventory

16. Standard Watershed Management (Form 7310-26)
    A. Rangeland Drill - Disc Plow
    B. Chaining
    C. Contour Furrowing
    D. Ripping
    E. Pitting
    F. Terracing
    G. Trenching
    H. Waterspreading
    I. Seeding

12. MUSGRAVE EQUATION (SHEET EROSION)

$$E = FR\ (S/10)^{1.35}\ (L/72.6)^{0.35}\ (P/1.375)^{1.7}$$

E = TONS / AC. / YR.

SOIL INVENTORY	A. F - BASIC EROSION RATE OF BARE SOIL IN TWO/YR.
STEP POINT TRANSECT	B. R - COVER FACTOR
BASE MAPS	C. S - AVERAGE SLOPE OF CONTRIBUTING AREA
BASE MAP	13. SEDIMENT DELIVERY RATIO CURVE - DRAINAGE AREA IN SQUARE MILES
SOIL INVENTORY STEP POINT TRANSECT SSF & MAPPING	14. SURFACE WATER RESOURCE INDICATORS OF SOURCE, TIMING, DISTRIBUTION, AMOUNT, QUALITY AND USES
SOIL INVENTORY	15. GROUND WATER INDICATORS OF STORAGE, RECHARGE AND QUALITY

	17. Indicator of Hydrologic Condition
Step Point Transect	A. Cover
Soil Inventory	B. Soil Group
Step Point Transect and Comparison Areas	C. Runoff Curve number (hydrologic cover complex)

Donald H. Fulton, State Resource Conservationist with Soil Conservation Service - Boise, Idaho

BLM/SCS Coordination of Plant Materials

Purpose of the Plant Material Center is to select and provide plant material for critical areas, forage, beautification, erosion areas, and the raising of breeder seed for all new released plants.

Meeting was held in Boise, Idaho, with representatives of BLM from Idaho, Nevada, and Utah on May 1, 1979, to discuss the following subjects:

1. Existing and projected needs for native plant materials to meet all range improvement needs.
2. Existing market and current agreements as to adequacy of supplying plant materials sources in meeting Bureau's future needs.
3. The extent to which SCS and FS capabilities can be expanded to meet BLM projected needs.
4. Agency wide or state level agreements with SCS and FS to expand existing programs to accommodate anticipated plant materials and seed needs.
5. Identifying funding needs and capability to reorient or expand current programs to meet projected needs with present personnel.
6. Identifying other options such as BLM or soil conservation districts assigning people to center to work on identified needs.

The Plant Material Center has released a new grass, Nezpar Indian Rice Grass. Another plant is to be released in the near future. It is a flax (Linum perenne Luwisii) of selected variety. The group was asked to vote on a new name for the flax plant.

The SCS and BLM have developed an interagency agreement where the Plant Material Center will work with the BLM which has a need of a seed source for selected shrubs and grasses adapted to southern Idaho that are presently unavailable on the commercial market. The present funding is for $10,000 but we need to expand the agreement and have Utah and Nevada consider financial assistance.

The Aberdeen, Idaho, Plant Material Center conducts a training session each spring and has made the training session available to BLM personnel. The training covers the harvesting, cleaning, and planting of mature seeds; also an inside look at all the projects going on at the Plant Material Center. The Center has aquired 60 additional acres which will increase their planting area for selected seed production.

There are several plant material centers which service the Great Basin area.

Aberdeen,Idaho - Southern Idaho, Northern Utah and Northern Nevada

Tucson, Arizona - Southern Utah, Southern Nevada

Pullman, Washington - North Idaho, Eastern Washington, and Eastern Oregon

Corvallis, Oregon - Western Oregon and Western Washington

In addition,a new center has recently been established at Meeker, Colorado,to work on materials for mine spoil reclamation.

WATER RESOURCES AND LIVESTOCK GRAZING ENVIRONMENTAL IMPACT STATEMENT PREPARATION

Karl Gebhardt (State Hydrologist, BLM, Idaho)

Introduction

Livestock grazing environmental impact statement (EIS) preparation is becoming the biggest time consumer in BLM programs today. The deadlines and requirements of the EIS preparation are causing many problems within the Bureau. Conversely, the EIS is helping BLM to improve inventory techniques, training procedures, and the overall awareness concerning the impacts of livestock grazing on public lands.

The basic format of the EIS involves several descriptive chapters. The second chapter, "Alternatives Including the Proposed Action," gives a detailed description of what is proposed, answering who, what, when, where, why, how much, and how. Chapter 2 also discusses the final impacts in summary form with adequate comparison. Chapter 2 is considered to be the heart of the EIS.

Chapter 3, "The Description of the Affected Environment," lays the framework for addressing possible impacts as well as providing the reader with a general understanding of the present environmental conditions. In actual writing, Chapter 3 is oftentimes prepared after a general impact analysis is completed to keep unnecessary description to a minimum. The CEQ (Council of Environmental Quality) guidelines have made it quite clear that descriptions of the affected environment "shall be no longer than is necessary to understand the effects of the alternatives."

Chapter 4, "Environmental Consequences," describes, in as much detail as considered necessary, the various impacts that may be produced through the implementation of the proposed action and alternatives. Chapter 4 should address both positive and negative changes that may occur and discuss any unknown or poorly understood impacts. Quantification has been deemed one of the most important parts of Chapter 4 in that it allows technical presentation which may lend itself to credibility. Where quantification is lacking, well selected references can strengthen the credibility of the impact analysis. Unquantifiable impacts should be addressed as descriptively as possible in order to give the reader an understanding of what is expected to happen.

Also in Chapter 4, mitigation can be addressed citing practices, guidelines, specifications, etc., that were not addressed in Chapter 2 which help to reduce adverse impacts. The measures are described in relation to their effectiveness in minimizing the impacts presented in Chapter 4. In the grazing ES, as many mitigating measures should be placed in the proposed action and alternatives as possible to reduce the need for Chapter 4 discussion.

The remaining chapters include references, glossary, list of preparers, consultation, and coordination used in the preparation of the document.

Problems

Many problems have plagued the EIS process in BLM. Some of the more important ones are listed below:

1. Too voluminous - Many people only read portions of the document and therefore some of the important interrelationships, analyses, gaps, and explanations are overlooked.

2. Difficult to understand - Many EIS's are written by an interdisciplinary team that fails to keep coordinated. As a result, descriptions may be conflicting, overly repeated, or incompatible. Proper editing is sometimes missing, allowing technical presentations to go unexplained. Impacts addressed in Chapter 4 sometimes go unaccounted for in other parts of the EIS, or new impacts crop up that were not originally discussed.

3. Poor analysis - As a result of poor analysis, including lack of documentation, failure to adequately summarize impacts upon ecosystems, and even overlooking serious impacts, the BLM and other Federal agencies have little credibility in the eyes of many EIS reviewers. For example, the Audubon Society has a guide for reviewing environmental impact statements that outlines detailed reviewing procedures and warns of poor analysis, coverup, and false representation by Federal agencies.

Hopefully, the CEQ guidelines on EIS preparation will minimize some of the problems, However, an improvement in impact analysis will undoubtedly do a great deal for making the EIS a credible document.

In my experience with EIS preparation and reviews, I have systemized my approach to their preparation and would like to describe some of the methods and important items relating to the preparation of the grazing environmental statement. I would briefly like to discuss the following items: Impacts, what are they? Understanding the proposed action. Describing the water resources impacts. Describing the existing environment.

Impacts, What Are They?

Impacts are changes in the existing environment brought about by an action. Every action contains elements that affect environmental change. These elements have been referred to as "change agents" (Fuchs, 1978). Change agents cause impacts that may be positive or

negative in various degrees of significance. Change agents may cause one or more impacts and the impacts may lead to other interrelated impacts that eventually can be related to man's environment. An example would be a grazing action (change agent) causing sedimentation in a stream (impact) causing a reduction in fish production (impact) which in turn reduces the recreation fishery (impact) which may reduce local revenues due to decreased visitation (impact). Such impact tracking is very straightforward but unfortunately may not be presented in the EIS. Lack of coordination is perhaps the biggest reason interdisciplinary impacts are overlooked. The legal definition of impact or "effects" is in Section 1508.8 of the CEQ guidelines, November 29 Federal Register and are termed indirect or direct. Effects must include those that are both detrimental and beneficial.

Understanding the Proposed Action

The proposed action and alternatives of the grazing EIS should adequately describe what, when, how, and where things will happen in an understandable manner. The water resources personnel must be able to pick out the various change agents and have enough description available to relate the change agents to potential impacts.

It is the duty of the water resources specialist to point out inconsistencies, gaps, and poor description in the proposed action at an early stage before the in-depth impact analysis begins. The stage for this input is in the preplanning analysis or at least during early reviews. In addition, it is very important that the hydrologist ask questions of the range specialists to clarify certain points in a proposed action that may be unclear or misinterpreted. Through proper use of the planning system, the proposed action should have considered the majority of impacts during developmental stages. Close coordination with the vegetation and soil writer is necessary to carry impacts to water resources. Also, the range specialist should be aware that future cover estimates are one of the most important requirements in assessing runoff and soil loss.

Describing the Existing Environment

It is possible and sometimes very desirable to write the descriptions of the environment after the impact analysis is completed. By doing this it is easy to leave out unimportant, lengthy descriptions that tend to confuse or bore a reader. The important aspects in the description of the existing environment should contain:

1. All relevant information required to understand Chapter 4.

2. Descriptions necessary to establish perspective.

3. Descriptions of data gaps.

Water resources and hydrologic descriptions can be very confusing because of unfamiliar jargon, units of measure, etc. Presentation of information should be as simple as possible to meet the needs of the non-technical reader and yet contain enough referencing and description to maintain a level of credibility with the reviewing hydrologist. This type of writing is very difficult but appears to be the only way to satisfy EIS requirements.

Describing the Impacts

Impact presentation is the primary purpose of the EIS. The EIS should address the major and significant impacts thoroughly and cover other impacts to a lesser degree commensurate with their importance. Hopefully, most of the impacts have been evaluated prior to the preparation of the proposed action. However, it is not uncommon to find little consideration for water resources and other related uses. The hydrologist must guarantee that the impacts covered in the EIS are accurate, well presented, understandable, and complete.

The remainder of this paper emphasizes the important factors in an impact analysis and methods for the water resources writer to approach the analysis. Important factors include literature reviews, change agents, available data, interrelationships (impact pathways) and significance.

Literature Reviews - A trip to the library is perhaps the writer's most valuable tool. Research in the grazing area is fast becoming a major literature producer, and reviewing the current abstracts, periodicals, etc., is really the only way to keepup-to-date. The computer search service, through the Department of Interior Library, offers a good way to obtain this information. The literature reviews helps the writer in many ways, including:

1. Familiarizing the writer with grazing impacts.

2. Evaluating inventory techniques.

3. Pointing out data gaps and areas that are not well understood.

4. Seeing presentation methods used by others.

Identifying the Change Agents - The proposed action should be thoroughly reviewed and each change agent should be identified and recorded. This allows for quick review and enables a thorough application to the impact analysis. Vegetation and soils analysis will also identify indirect change agents that may not be apparent in the proposed action.

Using Available Data - The available data may or may not have been specifically collected for the EIS. In any case, it is important that the available data apply to the problem at hand. Most general types of data sources like USGS, EPA, and State water resource agencies contain information that is helpful in establishing an understanding of the existing environment. These publications do not usually contain information specific to livestock grazing but do have the general information that is helpful in placing the water resources of the EIS area into a regional perspective. Inventory data specific to the EIS such as soil survey, vegetative and stream surveys may provide some useful information for supporting the impact analysis.

In the EIS narrative, data should only be presented to the extent necessary to describe the impacts. If large quantities of data are important to understanding the impact, they should be interpreted in the narrative and placed in the appendix. In many cases, graphical presentation can adequately represent the data and offers the advantage of being easy to understand while retaining credibility.

Interrelationships - The relationship of resource impact to another resource is perhaps the most important task of the EIS. An increase in sedimentation may be an impact in itself; however, the extent to which it affects another resource like fisheries, water supplies, reservoirs, etc., should be the ultimate goal of the impact description.

Interrelationships are identified in the latter stage of the impact analysis through the use of an interdisciplinary team of specialists. One method for tracking and identifying impacts is through the use of the "impact pathway" (Kauffman, personal communication). The impact pathway makes use of change agents and follows various "cause and effect" through each affected resource. The impact pathway provides a good means of record keeping and logical assessment.

Significance - Overall significance is perhaps the most difficult part of the impact description to provide. Significance of an impact can be judged through the use of quantification, comparison to standards and regulations, its cumulative affect, irreversibility, legislative requirements, and comparison to local or regional quantities and values. For example, the change of water quality may be more significant in a stream containing an endangered species than one containing other species. Significance must be addressed and the impact analysis should give the basis for presenting it in a logical manner.

Impact Analysis - Most livestock grazing impacts appear to be less important to water resources when compared on a regional level with irrigation, urban runoff, industrial waste, etc.; however, specific problems may be quite significant at a local level. Possible impacts from livestock grazing may include changes in nutrients, bacteria, temperature, water supply, water use, and often most important, sediment production. Predicting the future levels of the various parameters is

the most difficult task facing the EIS writer. Much of the quantification desired from the reviewers has resulted in pressured analysis which may exceed the prediction limits of the data. This "spaceage analysis with horse and buggy data" should be approached with extreme caution. A good example is the relationship of soil loss (usually sheet erosion) to actual instream sedimentation. Many reviewers generalize that the soil erosion can be directly related to stream sedimentation and even worse should be sufficient to predict adverse impacts upon stream uses such as fisheries. When the data for such analysis is unavailable, the writer should rely on a "worst case" approach and its probability of occurring to place the impact into perspective. Among the more significant problems are:

1. Grazing systems lack research documenting vegetative cover response. Future vegetative cover percentages are necessary to evaluate runoff and soil loss.

2. Many uses may not have established sediment tolerance levels. Such levels are necessary in order to place changes into positive or negative impact categories. For example, if a grazing system can be shown to improve sedimentation levels, that improvement would have to be related to levels that cause improvement in an existing use. This is necessary for the significance of the change to be evaluated.

3. Short inventory time (pre-EIS) does not allow for adequate watershed studies. As a result, many parameters are nearly impossible to quantify.

4. The ability for distribution techniques (watering, salt placement) to attract livestock from the stream corridor is not well understood. Observations showing both favorable and non-favorable results have caused this particular technique to be a major controversy.

5. Representative watershed studies are lacking in many EIS areas, thereby limiting the amount of detail that can be presented. Detailed watershed studies generally provide good information to use in impact analysis. Many findings of such studies can be directly applied to areas with similar environments. Unfortunately, these types of studies have not been widely conducted.

In analyzing impacts, I have found the use of a matrix to be quite helpful. After the change agents are identified, they are listed on the left hand margin of the matrix while possible impacted items are listed on the top (Figure 1). On a separate sheet of paper, the rationale for each mark on the matrix is recorded with a brief description of the available data.

The next step is an interdisciplinary analysis where each specialist reviews all the impacts and establishes interrelated impacts through the use of the impact pathway analysis (Figure 2).

At this point in the analysis, the impacts can be in order of significance. This information can then be plugged in the pre-planning analysis, pre-inventory analysis, inventory design, or be used to direct the writing of the EIS.

The matrix, impact pathway, etc., may seem to be a lot of unnecessary writing; however, in complex situations they provide good documentation of how the impacts were decided on. (Situations where many grazing allotments must be analyzed is a good example.) This documentation can be valuable when answering comments or designing post-implementation monitoring systems.

In summary, water resource writers should strive to produce environmental statements that are descriptive, concise, easy to understand, and, above all, cover the impacts that are relevant to livestock grazing. Systematic impact analysis techniques can improve EIS preparation through better impact and data-gap identification and by providing accurate and complete interdisciplinary analysis.

Limiting deadlines does not permit all of the water resource questions to be answered in the environmental statement; however, post-EIS monitoring may help to fill some of the gaps. It seems that water resources will become increasingly important, and those of us dealing with the resource should insure that future monitoring techniques provide the required information.

IMPACT MATRIX

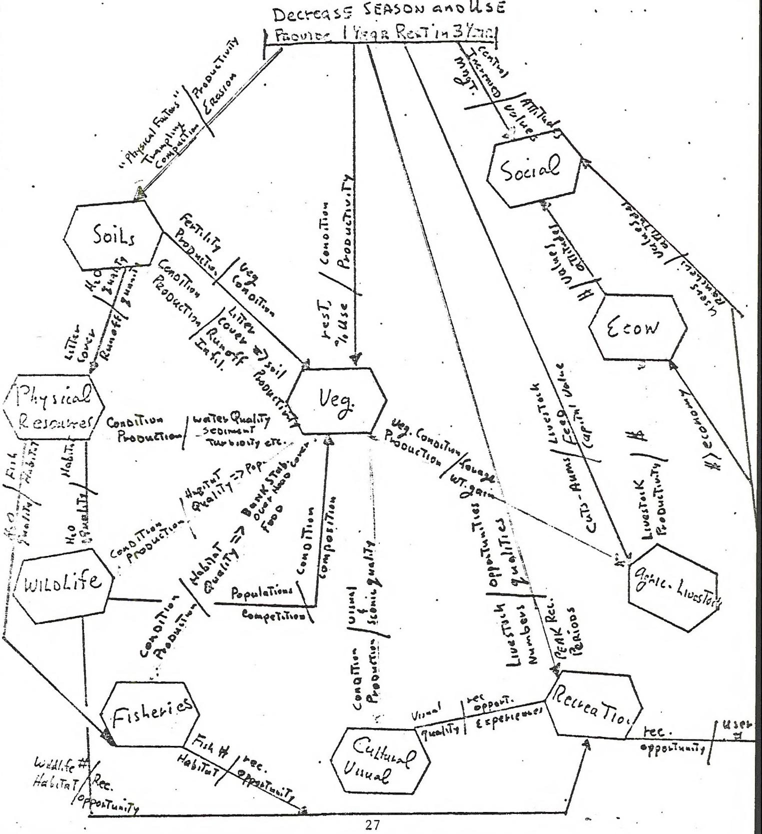
Change Agent	Direct Runoff	Yield	Supply	Use	Nutrients	Bacteria	Transported Sediment	Sheet Erosion	Channel Erosion	Temperature	Turbidity					
Grazing System																
Season																
Forage allocation																
livestock numbers																
trailing																
Rangeland Improvements																
Fences																
Water Developments																
Vegetative Manipulation																
Seeding																
Burning																
Chaining																
Spraying																

+, –, o, ?,Positive, Negative, No impact, Unknown
L, M. H, ?, Low, Medium, High, ?
N.A. - Not applicable
S - Surface; G - Ground

— Direct Pathways
— 2nd Pathways
— 3rd Pathways
— 4th or lower Patways

PROPOSED ACTION

Change Agent



ANALYSIS OF IMPACTS ON VEGETATION

source tegory	Existing Situation	Proposed Management Action	Change From Present Management	Specific Causes of any Probable Impacts	Probable Impacts and Explanation	Documentation of Impacts	Area Affected	Time Frame	Comparison with Planning Objectives	Interrelationship with Other Resources & Activities
vestock orage ondition	Fair condition on 40,000 acres and poor condition on 10,000 acres.	Implement improved grazing management. Graze in spring and summer (5/1 to 9/15) with year-long rest at least 1 year out of 3.	Would provide periodic rest during growing season in contrast to continuous grazing during spring and summer each year.	Cattle grazing patterns and food preferences during the grazing treatments. Improved distribution of cattle during the grazing treatments. Absence of cattle grazing during the resting treatment.	Key species of livestock forage plants would be able to complete growth & reproductive processes at least 1 year out of 3. Vigor and density of desirable livestock forage plants would increase. Increased competition would result in a decrease of undesirable livestock forage plants. The above would result in a livestock forage condition that was on 45,000 acres and fair on 5,000 acres.	Based on published research by Hormay (1965) and Smith (1972). Based on unpublished range studies of 3 similar allotments in the District under similar management since 1970.	Big Creek, Flat Rock North Ridge, Sandy and Willow allotments. 50,000 acres.	10 to 15 years	Fulfills 90% of objective for achieving a good livestock forage condition on 50,000 acres in the 5 allotments.	Fish & Wildlife Habitat Watershed Livestock Operations

SUMMARY OF IMPACTS ON VEGETATION 1/

Resource Category	Area Affected	Probable Impacts	Relationship to Proposed Action
Livestock forage condition.	All 20 allotments in planning unit. 20,000 acres.	The physiological requirements of key livestock forage plants would be met and the vigor and density of desirable livestock forage plants would increase. Increased competition would decrease the undesirable plants. (Hormay, 1965 and Smith, 1972). Livestock forage condition would improve over 10-20 years from 90% fair (180,000) acres and 10% poor (20,000) acres to 70% good (140,000 acres) and 30% fair (60,000) acres (unpublished range studies, ______ District).	Continuation of existing rest-rotation, deferred rotation, and deferred management systems and implementation of improved grazing management utilizing grazing and resting treatments would provide periodic rest for key livestock forage plants during the growing season. This would occur in all 20 allotments (200,000 acres) rather than in 14 (120,000) as presently occurs. The predicted impacts would be caused by the periodic absence of livestock grazing during the growing season (20 allotments), the specific grazing patterns and food preferences of cattle and sheep (20 allotments), and improved livestock distribution during the grazing treatments (8 allotments). The predicted impacts would fulfill 70% of planning objective for achieving a good livestock forage condition on all 200,000 acres within the 20 allotments.

1/ See Table __ in Appendix __ for additional detail.

Chapter 3 Narrative on Vegetation

Introduces the subject

Puts vegetation in perspective as related to the other resources in the chapter

Introduces the summary table

Highlights the most significant overall impacts to vegetation

Gives examples of impacts, quantification, and reasoning from other studies

Contacts and References

Fuchs, Everett (Bud), Donald R. Cain 1978. Guidelines for Conducting an Environmental Impact Assessment. Utah State Office, BLM

Audubon Society, 1975 Environmental Impact Statements, How to Analyze Them. Edward M. Brigham III North-Midwest Representative. National Audubon Society

Kauffman, Dave - Team Leader, Randolph Grazing ES.

Mozian, Zareh - Physical Scientist, BLM, Environmental Assistance.

Council on Environmental Quality - 1978. Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act. Federal Register. 43 FR 55978-56007, November 29, 1978.

Council on Environmental Quality
Executive Office of the President

REGULATIONS
For Implementing The Procedural Provisions Of The
NATIONAL ENVIRONMENTAL POLICY ACT

Reprint
43 FR 55978–56007
November 29, 1978
40 CFR Parts 1500–1508

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PART 1500—PURPOSE, POLICY, AND MANDATE

1500.1 Purpose.
1500.2 Policy.
1500.3 Mandate.
1500.4 Reducing paperwork.
1500.5 Reducing delay.
1500.6 Agency authority.

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), section 309 of the Clean Air Act, as amended (42 U.S.C. 7609) and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970 as amended by Executive Order 11991, May 24, 1977).

§ 1500.1 Purpose.

(a) The National Environmental Policy Act (NEPA) is our basic national charter for protection of the environment. It establishes policy, sets goals (section 101), and provides means (section 102) for carrying out the policy. Section 102(2) contains "action-forcing" provisions to make sure that federal agencies act according to the letter and spirit of the Act. The regulations that follow implement Section 102(2). Their purpose is to tell federal agencies what they must do to comply with the procedures and achieve the goals of the Act. The President, the federal agencies, and the courts share responsibility for enforcing the Act so as to achieve the substantive requirements of section 101.

(b) NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. Most important, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail.

(c) Ultimately, of course, it is not better documents but better decisions that count. NEPA's purpose is not to generate paperwork—even excellent paperwork—but to foster excellent action. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment. These regulations provide the direction to achieve this purpose.

§ 1500.2 Policy.

Federal agencies shall to the fullest extent possible:

(a) Interpret and administer the policies, regulations, and public laws of the United States in accordance with the policies set forth in the Act and in these regulations.

(b) Implement procedures to make the NEPA process more useful to decisionmakers and the public; to reduce paperwork and the accumulation of extraneous background data; and to emphasize real environmental issues and alternatives. Environmental impact statements shall be concise, clear, and to the point, and shall be supported by evidence that agencies have made the necessary environmental analyses.

(c) Integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run con-

after the application is received. Federal agencies are encouraged to begin preparation of such assessments or statements earlier, preferably jointly with applicable State or local agencies.

(c) For adjudication, the final environmental impact statement shall normally precede the final staff recommendation and that portion of the public hearing related to the impact study. In appropriate circumstances the statement may follow preliminary hearings designed to gather information for use in the statements.

(d) For informal rulemaking the draft environmental impact statement shall normally accompany the proposed rule.

§ 1502.6 Interdisciplinary preparation.

Environmental impact statements shall be prepared using an inter-disciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts (section 102(2)(A) of the Act). The disciplines of the preparers shall be appropriate to the scope and issues identified in the scoping process (§ 1501.7).

§ 1502.7 Page limits.

The text of final environmental impact statements (e.g., paragraphs (d) through (g) of § 1502.10) shall normally be less than 150 pages and for proposals of unusual scope or complexity shall normally be less than 300 pages.

§ 1502.8 Writing.

Environmental impact statements shall be written in plain language and may use appropriate graphics so that decisionmakers and the public can readily understand them. Agencies should employ writers of clear prose or editors to write, review, or edit statements, which will be based upon the analysis and supporting data from the natural and social sciences and the environmental design arts.

§ 1502.9 Draft, final, and supplemental statements.

Except for proposals for legislation as provided in § 1506.8 environmental impact statements shall be prepared in two stages and may be supplemented.

(a) Draft environmental impact statements shall be prepared in accordance with the scope decided upon in the scoping process. The lead agency shall work with the cooperating agencies and shall obtain comments as required in Part 1503 of this chapter. The draft statement must fulfill and satisfy to the fullest extent possible the requirements established for final statements in section 102(2)(C) of the Act. If a draft statement is so inadequate as to preclude meaningful analysis, the agency shall prepare and circulate a revised draft of the appropriate portion. The agency shall make every effort to disclose and discuss at appropriate points in the draft statement all major points of view on the environmental impacts of the alternatives including the proposed action.

(b) Final environmental impact statements shall respond to comments as required in Part 1503 of this chapter. The agency shall discuss at appropriate points in the final statement any responsible opposing view which was not adequately discussed in the draft statement and shall indicate the agency's response to the issues raised.

(c) Agencies:

(1) Shall prepare supplements to either draft or final environmental impact statements if:

(i) The agency makes substantial changes in the proposed action that are relevant to environmental concerns; or

(ii) There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.

(2) May also prepare supplements when the agency determines that the purposes of the Act will be furthered by doing so.

(3) Shall adopt procedures for introducing a supplement into its formal administrative record, if such a record exists.

(4) Shall prepare, circulate, and file a supplement to a statement in

the same fashion (exclusive of scoping) as a draft and final statement unless alternative procedures are approved by the Council.

§ 1502.10 Recommended format.

Agencies shall use a format for environmental impact statements which will encourage good analysis and clear presentation of the alternatives including the proposed action. The following standard format for environmental impact statements should be followed unless the agency determines that there is a compelling reason to do otherwise:

(a) Cover sheet.

(b) Summary.

(c) Table of Contents.

(d) Purpose of and Need for Action.

(e) Alternatives Including Proposed Action (secs. 102(2)(C)(iii) and 102(2)(E) of the Act).

(f) Affected Environment.

(g) Environmental Consequences (especially sections 102(2)(C) (i), (ii), (iv), and (v) of the Act).

(h) List of Preparers.

(i) List of Agencies, Organizations, and Persons to Whom Copies of the Statement Are Sent.

(j) Index.

(k) Appendices (if any).

If a different format is used, it shall include paragraphs (a), (b), (c), (h), (i), and (j), of this section and shall include the substance of paragraphs (d), (e), (f), (g), and (k) of this section, as further described in §§ 1502.11–1502.18, in any appropriate format.

§ 1502.11 Cover sheet.

The cover sheet shall not exceed one page. It shall include:

(a) A list of the responsible agencies including the lead agency and any cooperating agencies.

(b) The title of the proposed action that is the subject of the statement (and if appropriate the titles of related cooperating agency actions), together with the State(s) and county(ies) (or other jurisdiction if applicable) where the action is located.

(c) The name, address, and telephone number of the person at the agency who can supply further information.

(d) A designation of the statement as a draft, final, or draft or final supplement.

(e) A one paragraph abstract of the statement.

(f) The date by which comments must be received (computed in cooperation with EPA under § 1506.10).

The information required by this section may be entered on Standard Form 424 (in items 4, 6, 7, 10, and 18).

§ 1502.12 Summary.

Each environmental impact statement shall contain a summary which adequately and accurately summarizes the statement. The summary shall stress the major conclusions, areas of controversy (including issues raised by agencies and the public), and the issues to be resolved (including the choice among alternatives). The summary will normally not exceed 15 pages.

§ 1502.13 Purpose and need.

The statement shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action.

§ 1502.14 Alternatives including the proposed action.

This section is the heart of the environmental impact statement. Based on the information and analysis presented in the sections on the Affected Environment (§ 1502.15) and the Environmental Consequences (§ 1502.16), it should present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public. In this section agencies shall:

(a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.

(b) Devote substantial treatment to each alternative considered in detail including the proposed action

so that reviewers may evaluate their comparative merits.

(c) Include reasonable alternatives not within the jurisdiction of the lead agency.

(d) Include the alternative of no action.

(e) Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.

(f) Include appropriate mitigation measures not already included in the proposed action or alternatives.

§ 1502.15 Affected environment.

The environmental impact statement shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced. Agencies shall avoid useless bulk in statements and shall concentrate effort and attention on important issues. Verbose descriptions of the affected environment are themselves no measure of the adequacy of an environmental impact statement.

§ 1502.16 Environmental consequences.

This section forms the scientific and analytic basis for the comparisons under § 1502.14. It shall consolidate the discussions of those elements required by secs. 102(2)(C) (i), (ii), (iv), and (v) of NEPA which are within the scope of the statement and as much of sec. 102(2)(C)(iii) as is necessary to support the comparisons. The discussion will include the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented. This section should not duplicate discussions in § 1502.14. It shall include discussions of:

(a) Direct effects and their significance (§ 1508.8).

(b) Indirect effects and their significance (§ 1508.8).

(c) Possible conflicts between the proposed action and the objectives of Federal, regional, State, and local (and in the case of a reservation, Indian tribe) land use plans, policies and controls for the area concerned. (See § 1506.2(d).)

(d) The environmental effects of alternatives including the proposed action. The comparisons under § 1502.14 will be based on this discussion.

(e) Energy requirements and conservation potential of various alternatives and mitigation measures.

(f) Natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures.

(g) Urban quality, historic and cultural resources, and the design of the built environment, including the reuse and conservation potential of various alternatives and mitigation measures.

(h) Means to mitigate adverse environmental impacts (if not fully covered under § 1502.14(f)).

§ 1502.17 List of preparers.

The environmental impact statement shall list the names, together with their qualifications (expertise, experience, professional disciplines), of the persons who were primarily responsible for preparing the environmental impact statement or significant background papers, including basic components of the statement (§§ 1502.6 and 1502.8). Where possible the persons who are responsible for a particular analysis, including analyses in background papers, shall be identified. Normally the list will not exceed two pages.

§ 1502.18 Appendix.

If an agency prepares an appendix to an environmental impact statement the appendix shall:

(a) Consist of material prepared in connection with an environmental impact statement (as distinct from material which is not so prepared and which is incorporated by reference (§ 1502.21)).

(b) Normally consist of material which substantiates any analysis fundamental to the impact statement.

(c) Normally be analytic and relevant to the decision to be made.

(d) Be circulated with the environmental impact statement or be readily available on request.

§ 1502.19 Circulation of the environmental impact statement.

Agencies shall circulate the entire draft and final environmental impact statements except for certain appendices as provided in § 1502.18(d) and unchanged statements as provided in § 1503.4(c). However, if the statement is unusually long, the agency may circulate the summary instead, except that the entire statement shall be furnished to:

(a) Any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved and any appropriate Federal, State or local agency authorized to develop and enforce environmental standards.

(b) The applicant, if any.

(c) Any person, organization, or agency requesting the entire environmental impact statement.

(d) In the case of a final environmental impact statement any person, organization, or agency which submitted substantive comments on the draft.

If the agency circulates the summary and thereafter receives a timely request for the entire statement and for additional time to comment, the time for that requestor only shall be extended by at least 15 days beyond the minimum period.

§ 1502.20 Tiering.

Agencies are encouraged to tier their environmental impact statements to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review (§ 1508.28). Whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment is then prepared on an action included within the entire program or policy (such as a site specific action) the subsequent statement or environmental assessment need only summarize the issues discussed in the broader statement and incorporate discussions from the broader statement by reference and shall concentrate on the issues specific to the subsequent action. The subsequent document shall state where the earlier document is available. Tiering may also be appropriate for different stages of actions. (Sec. 1508.28).

§ 1502.21 Incorporation by reference.

Agencies shall incorporate material into an environmental impact statement by reference when the effect will be to cut down on bulk without impeding agency and public review of the action. The incorporated material shall be cited in the statement and its content briefly described. No material may be incorporated by reference unless it is reasonably available for inspection by potentially interested persons within the time allowed for comment. Material based on proprietary data which is itself not available for review and comment shall not be incorporated by reference.

§ 1502.22 Incomplete or unavailable information.

When an agency is evaluating significant adverse effects on the human environment in an environmental impact statement and there are gaps in relevant information or scientific uncertainty, the agency shall always make clear that such information is lacking or that uncertainty exists.

(a) If the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are not exorbitant, the agency shall include the information

in the environmental impact statement.

(b) If (1) the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are exorbitant or (2) the information relevant to adverse impacts is important to the decision and the means to obtain it are not known (e.g., the means for obtaining it are beyond the state of the art) the agency shall weigh the need for the action against the risk and severity of possible adverse impacts were the action to proceed in the face of uncertainty. If the agency proceeds, it shall include a worst case analysis and an indication of the probability or improbability of its occurrence.

§ 1502.23 Cost-benefit analysis.

If a cost-benefit analysis relevant to the choice among environmentally different alternatives is being considered for the proposed action, it shall be incorporated by reference or appended to the statement as an aid in evaluating the environmental consequences. To assess the adequacy of compliance with sec. 102(2)(B) of the Act the statement shall, when a cost-benefit analysis is prepared, discuss the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amenities. For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are important qualitative considerations. In any event, an environmental impact statement should at least indicate those considerations, including factors not related to environmental quality, which are likely to be relevant and important to a decision.

§ 1502.24 Methodology and scientific accuracy.

Agencies shall insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements. They shall identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions in the statement. An agency may place discussion of methodology in an appendix.

§ 1502.25 Environmental review and consultation requirements.

(a) To the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with environmental impact analyses and related surveys and studies required by the Fish and Wildlife Coordination Act (16 U.S.C. Sec. 661 et seq.), the National Historic Preservation Act of 1966 (16 U.S.C. Sec. 470 et seq.), the Endangered Species Act of 1973 (16 U.S.C. Sec. 1531 et seq.), and other environmental review laws and executive orders.

(b) The draft environmental impact statement shall list all Federal permits, licenses, and other entitlements which must be obtained in implementing the proposal. If it is uncertain whether a Federal permit, license, or other entitlement is necessary, the draft environmental impact statement shall so indicate.

PART 1503—COMMENTING

Sec.
1503.1 Inviting Comments.
1503.2 Duty to Comment.
1503.3 Specificity of Comments.
1503.4 Response to Comments.

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609), and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1503.1 Inviting comments.

(a) After preparing a draft environmental impact statement and before preparing a final environmental impact statement the agency shall:

(1) Obtain the comments of any Federal agency which has jurisdic-

§ 1508.7 Cumulative impact.

"Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

§ 1508.8 Effects.

"Effects" include:

(a) Direct effects, which are caused by the action and occur at the same time and place.

(b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

§ 1508.9 Environmental assessment.

"Environmental Assessment":

(a) Means a concise public document for which a Federal agency is responsible that serves to:

(1) Briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact.

(2) Aid an agency's compliance with the Act when no environmental impact statement is necessary.

(3) Facilitate preparation of a statement when one is necessary.

(b) Shall include brief discussions of the need for the proposal, of alternatives as required by sec. 102(2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.

§ 1508.10 Environmental document.

"Environmental document" includes the documents specified in § 1508.9 (environmental assessment), § 1508.11 (environmental impact statement), § 1508.13 (finding of no significant impact), and § 1508.22 (notice of intent).

§ 1508.11 Environmental impact statement.

"Environmental Impact Statement" means a detailed written statement as required by Sec. 102(2)(C) of the Act.

§ 1508.12 Federal agency.

"Federal agency" means all agencies of the Federal Government. It does not mean the Congress, the Judiciary, or the President, including the performance of staff functions for the President in his Executive Office. It also includes for purposes of these regulations States and units of general local government and Indian tribes assuming NEPA responsibilities under section 104(h) of the Housing and Community Development Act of 1974.

§ 1508.13 Finding of no significant impact.

"Finding of No Significant Impact" means a document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded (§ 1508.4), will not have a significant effect on the human environment and for which an environmental impact statement therefore will not be prepared. It shall include the environmental assessment or a summary of it and shall note any other environmental documents related to it (§ 1501.7(a)(5)). If the assessment is included, the finding need not repeat any of the discussion in the assessment but may incorporate it by reference.

§ 1508.14 Human Environment.

"Human Environment" shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment. (See the definition of "effects" (§ 1508.8).) This means that economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment.

§ 1508.15 Jurisdiction By Law.

"Jurisdiction by law" means agency authority to approve, veto, or finance all or part of the proposal.

§ 1508.16 Lead agency.

"Lead Agency" means the agency or agencies preparing or having taken primary responsibility for preparing the environmental impact statement.

§ 1508.17 Legislation.

"Legislation" includes a bill or legislative proposal to Congress developed by or with the significant cooperation and support of a Federal agency, but does not include requests for appropriations. The test for significant cooperation is whether the proposal is in fact predominantly that of the agency rather than another source. Drafting does not by itself constitute significant cooperation. Proposals for legislation include requests for ratification of treaties. Only the agency which has primary responsibility for the subject matter involved will prepare a legislative environmental impact statement.

§ 1508.18 Major Federal action.

"Major Federal action" includes actions with effects that may be major and which are potentially subject to Federal control and responsibility. Major reinforces but does not have a meaning independent of significantly (§ 1508.27). Actions include the circumstance where the responsible officials fail to act and that failure to act is reviewable by courts or administrative tribunals under the Administrative Procedure Act or other applicable law as agency action.

(a) Actions include new and continuing activities, including projects and programs entirely or partly financed, assisted, conducted, regulated, or approved by federal agencies; new or revised agency rules, regulations, plans, policies, or procedures; and legislative proposals (§§ 1506.8, 1508.17). Actions do not include funding assistance solely in the form of general revenue sharing funds, distributed under the State and Local Fiscal Assistance Act of 1972, 31 U.S.C. 1221 et seq., with no Federal agency control over the subsequent use of such funds. Actions do not include bringing judicial or administrative civil or criminal enforcement actions.

(b) Federal actions tend to fall within one of the following categories:

(1) Adoption of official policy, such as rules, regulations, and interpretations adopted pursuant to the Administrative Procedure Act, 5 U.S.C. 551 et seq.; treaties and international conventions or agreements; formal documents establishing an agency's policies which will result in or substantially alter agency programs.

(2) Adoption of formal plans, such as official documents prepared or approved by federal agencies which guide or prescribe alternative uses of federal resources, upon which future agency actions will be based.

(3) Adoption of programs, such as a group of concerted actions to implement a specific policy or plan; systematic and connected agency decisions allocating agency resources to implement a specific statutory program or executive directive.

(4) Approval of specific projects, such as construction or management activities located in a defined geographic area. Projects include actions approved by permit or other regulatory decision as well as federal and federally assisted activities.

viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequencies together, such as common timing or geography. An agency may wish to analyze these actions in the same impact statement. It should do so when the best way to assess adequately the combined impacts of similar actions or reasonable alternatives to such actions is to treat them in a single impact statement.

(b) Alternatives, which include: (1) No action alternative. (2) Other reasonable courses of actions. (3) Mitigation measures (not in the proposed action).

(c) Impacts, which may be: (1) Direct. (2) Indirect. (3) Cumulative.

§ 1508.26 Special expertise.

"Special expertise" means statutory responsibility, agency mission, or related program experience.

§ 1508.27 Significantly.

"Significantly" as used in NEPA requires considerations of both context and intensity:

(a) *Context.* This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.

(b) *Intensity.* This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:

(1) Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.

(2) The degree to which the proposed action affects public health or safety.

(3) Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.

(4) The degree to which the effects on the quality of the human environment are likely to be highly controversial.

(5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.

(6) The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

(7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

(8) The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.

(9) The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.

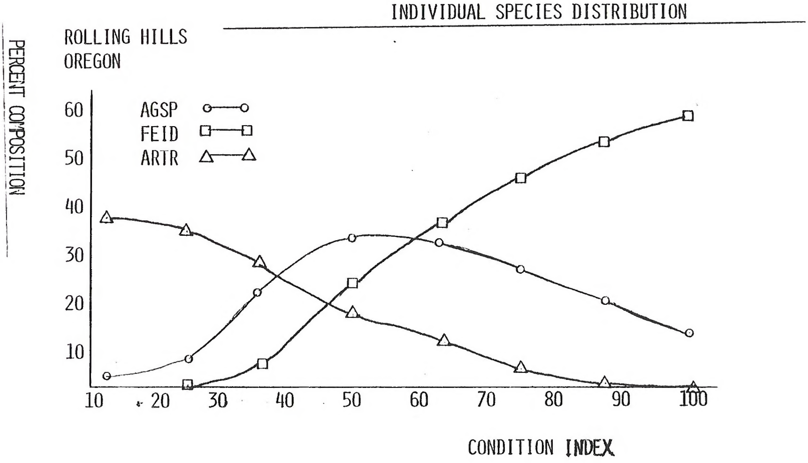
(10) Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

§ 1508.28 Tiering.

"Tiering" refers to the coverage of general matters in broader environmental impact statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basinwide program statements or ultimately site-specific statements) incorporating by reference the general discussions and concentrating solely on

RANGE SITE DESCRIPTION-EXPECTED PLANT COMMUNITIES
PERCENT COMPOSITION

RANGE SITE (RH)	SERAL[1] STAGE								
		LOW		MEDIUM		HIGH		CLIMAX	
	0	12	25	37	50	63	75	88	100
GRASS									
AGSP		2	9	21	33	32	27	22	13
FEID				7	24	37	46	52	59
POSE		27	19	8	5	5	5	5	5
OTHER		10	10	7	5	4	3	4	4
FORBS		15	9	9	5	5	6	7	7
SHRUB									
ARTR2		38	35	29	19	11	5	1	
OTHER		8	16	15	7	5	6	9	12
TOTAL PROD. LBS/AC NORM. YR.		529	548	595	683	750	798	826	860


INDIVIDUAL SPECIES DISTRIBUTION
ROLLING HILLS
OREGON
PERCENT COMPOSITION
60
50
40
30
20
10
AGSP
FEID
ARTR
10
20
30
40
50
60
70
80
90
100
CONDITION INDEX

EXPECTED PLANT COMMUNITIES
PRODUCTION IN LBS/ACRE (NORMAL/YR)

RANGE SITE
(RH)

SERAL STAGE

		LOW		MEDIUM		HIGH		CLIMAX	
	0	12	25	37	50	63	75	88	100
GRASS									
AGSP		11	49	125	225	240	215	182	112
FEID				42	164	278	367	430	507
POSE		143	104	48	34	37	40	41	43
OTHER		53	55	42	34	31	24	33	35
FORBS		79	48	54	34	37	48	58	60
SHRUB									
ARTR2		201	192	173	130	82	40	8	
OTHER		43	77	90	49	35	48	76	103
TOTAL		529	548	595	683	750	798	826	860

MANAGEMENT INTERPRETATIONS

R.H. RANGE SITE

	SERAL STAGES			
FACTOR RATED	CLIMAX	HIGH	MEDIUM	LOW
WATER QUAN.	+1	+2	+3	+4
WATER QUAL.	+1	+2	+3	+4
BIGHORN SHEEP	+1	+2	+3	-4
ANTELOPE	+3	+1	+2	+4
MULE DEER WINTER	+2	-4	+1	-3
MULE DEER SUMMER	+3	+2	+1	+4
SAGE GROUSE	--	+3	+2	+1
LONG BILL CURLEW	-4	-3	-2	+1
RAPTOR FORAGING	+4	+3	+1	+2
ELK WINTER	+4	+2	+1	+3
WILD HORSE	+1	+2	+3	+4
LIVESTOCK	+1	+2	+3	+4

1 = BEST += SATISFACTORY HABITAT CONDITION
4 = WORST -= UNSATISFACORY HABITAT CONDITION

RELATIONSHIP OF WILDLIFE HABITAT TO RANGE SITES BY SERAL STAGES

RANGE SITES	SERAL STAGES CLIMAX	HIGH	MEDUM	LOW
RAPTOR FORAGING				
ARH	--	+3	+1	+2
DRH	--	+3	+1	+2
RH	+4	+3	+1	+2
SC	+2	+1	+3	--
MSC	+3	+2	+1	--
SDS	+4	+3	+2	+1
SDN	+4	+2	+1	+3
MULE DEER (SUMMER)				
ARH	-4	-3	+2	+1
DRH	+4	+2	+1	+3
RH	+3	+2	+1	+4
SC	+1	+2	+3	+4
MSC	+3	+2	+1	--
SDS	+2	+4	+1	+3
SDN	+4	+1	+2	+3
ANTELOPE				
ARH	+3	+1	+2	+4
DRH	+3	+1	+2	+4
RH	+3	+1	+2	+4
SC	+2	+1	+3	--
MSC	+3	+1	+2	--
SDS	+4	+2	+1	+3
SDN	+3	+2	+1	+4

1 = BEST
4 = WORST

+ = SATISFACTORY HABITAT CONDITION
- = UNSATISFACTORY HABITAT CONTITION

RELATIONSHIP OF SVIM TO CULTURAL RESOURCES

SVIM PROVIDES THE KEY TO WHERE POTENTIAL PLANT COMMUNITIES OCCURRED EVEN THOUGH THEY ARE NOW ABSENT.

CHRIS CORSON - SUSANVILLE DISTRICT - IS PRESENTLY STUDYING THE OCCURRENCE OF CULTURAL RESOURCES IN RELATION TO:

1. WHERE KEY PLANT MATERIALS EXISTED
2. PATTERNS OF WILDLIFE MOVEMENT (ESP. BIGHORN SHEEP) AS RELATED TO POTENTIAL VEGETATION, HAS IDENTIFIED 500 SQ. MI. OF A HUNTING COMPLEX THAT DOES NOT PRESENTLY EXIST

A.R.H. RANGE SITE
OREGON

RELATIONSHIP OF WILDLIFE HABITAT TYPES TO SERAL STAGES FOR A.R.H. RANGE SITE

SERIAL STAGE	STANDARD WILDLIFE HABITAT TYPE	RANGE ECO* NO.
LOW	ORHD0014	36
MED	ORHD0014	36
HIGH	ORHD0014	36
CLIMAX	ORHD0024	34

*AFTER SUNDSTROM

A.R.H. RANGE SITE
OREGON

STANDARD WILDLIFE HABITAT TYPE

WILDLIFE SPECIES	ORHD0024 (34 RNG, ECO)	ORHD0014 (36 RNG, ECO)
	SERAL STAGES	
	CLIMAX	HIGH
LIST OF 326 EXAMPLES ARE:		
WESTERN TOAD	XO	XO
WESTERN SKINK	XO	--
YELLOW BELLIED RACER	XO	--
GAD WALL	XO	--
BLUE WINGED TEAL	XO	XO
SNOW GOOSE	O	O

X=REPRODUCES

O=FEEDS

RELATIONSHIP TO FIRE MANAGEMENT

1. FIRE MANAGEMENT OPPORTUNITIES AND CONSTRAINTS TO ACHIEVE MANAGEMENT GOALS

    INTENSIVE SURPRESSION
    MODIFIED SURPRESSION
    PRESCRIBED FIRE

2. KINDS AND DISTRIBUTION OF FUEL

3. AMOUNTS OF FUEL BY SPECIES

    GRAZING SYSTEMS
    CURRENT PPT.

4. CONSTRUCT FUEL MODEL MAP

5. FIRE DANGER RATING ON CONDITION CLASSES X RANGE SITES

PHENOLOGICAL EFFECTS OF A LOW INTENSITY BURN AT DORMANCY

SPECIES	MORTALITY	RECOVERY	
ARTR	90 - 95 %	CAN BE AGGRESSIVE	20 - 30 YEARS
PUTR	90 - 100%	POOR RECOVERY	30 - 40
CHVI	LOW	GOOD	1 - 3
AGSP	LOW	GOOD	1 - 3
BRTE	HIGH	RAPID	1 - 2
LUPINE	LOW	GOOD	1 - 2
JUOS	HIGH	EASILY KILLED	20 - 30

AFTER CHERRY CR. P.M, ELY, NEV

OTHER APPLICATIONS OF SVIM DATA

WE HAVE JUST BEGUN TO LEARN

VRM
WATERSHED
ECT.

OREGON UPPER SNAKE RIVER LAVA PLAINS HANDBOOK

SITE SYMBOL
OR SR RH

ROLLING HILLS
MLRAS B10 023

EXPECTED PLANT COMMUNITIES
(PERCENT COMPOSITION BY SPECIES)

SERAL STAGE		EARLY	//	MID	//	LATE	//	CLIMAX	//
% OF CLIMAX	0	12	25	37	50	63	75	88	100
GRASSES									
AGSP		2	9	21	33	32	27	22	13
BRTE		6	4	2	1	1	1		
FEID				7	24	37	46	52	59
POSE		27	19	8	5	5	5	5	5
SIHY		4	4	3	3	2	1	1	1
STIPA			2	2	1	1	1	3	3
(TOTAL)	( )	(39)	(38)	(43)	(67)	(78)	(81)	(83)	(81)
FORBS									
AAFF		3	2	1				1	2
ANTEN		1							
EPPA2		1	1	1					
ERIGE2				1	1	1	1		
ERIOG			1	2	1	2	3	4	5
LUPIN				4	3	2	2	2	
PHLOX		10	5						
(TOTAL)	( )	(15)	(9)	(9)	(5)	(5)	(6)	(7)	(7)
SHRUBS									
ARAR8		2	8	7	2	1	3	2	2
ARTR2		38	35	29	19	11	5	1	
ARTR4					1	1	1	3	5
CHNA2		6	5	4	2	1			
CHVI8			2	2	1	1	1	2	2
PUTR2			1	2	1	1	1	2	3
(TOTAL)	( )	(46)	(51)	(44)	(26)	(16)	(11)	(10)	(12)
TREES									
JUOC			2	4	2	1	1		
(TOTAL)	( )	( )	(2)	(4)	(2)	(1)	(1)	( )	( )
TOTAL ANNUAL PRODUCTION (POUNDS PER ACRE)									
NORYR		529	548	595	683	750	798	826	860
UNFYR		222	230	250	287	315	335	347	361

FLOODPLAIN AND WETLAND MANAGEMENT
IDAHO WATER RESOURCES WORKSHOP, November 27-29, 1979 Boise, Idaho

DAVID H. FORTIER, HYDROLOGIST
BLM Coeur d'Alene District

Floodplain and wetland management policy and procedures are based largely on E.O. 11988 - Floodplain Management (May 24, 1977) and E.O. 11990 - Protection of Wetlands (May 24, 1977). The executive orders have many similarities in requiring the protection of floodplains and wetlands and a decision-making process with public involvement. The BLM policy and protection procedures for floodplain management are found in Manual section 7221 (44 FR 15784, March 15, 1979). For BLM wetlands management, a notice of availability was published (43 FR 52171, November 8. 1978) and can be found in the Draft Manual section 6740 concerning Wetland-Riparian Area Protection and Management.

The management areas of floodplains and wetlands often overlap and usually also include riparian areas. Therefore, the management of these areas must be coordinated and often support each other. The basic definitions of areas are given below as taken from the BLM manuals:

1. Floodplain - Land areas susceptible to being flood-inundated from any source, including small and often dry watercourses and areas adjoining coastal waters, areas along rivers, streams, and lakes.
    - Base Floodplain - The 100-year floodplain (0.1 percent chance floodplain.
    - Critical Floodplain - The 500-year floodplain (0.2 percent chance floodplain.

2. Wetland or wetland habitat - Permanently wet or intermittently flooded areas where the water table (fresh, saline, or brackish) is at, near, or above the soil surface for extended intervals, where hydric wet soil conditions are normally exhibited, and where water depths generally do not exceed 2 meters. Vegetation is generally comprised of emergent water-loving forms (hydrophytes) which require at least a periodically saturated soil condition for growth and reproduction. In certain instances, vegetation may be completely lacking. Marshes, shallows, swamps, muskegs, lake bogs, and wet meadows are examples of wetlands.

3. Riparian Habitat - A specialized form of wetland restricted to areas along, adjacent to, or contiguous with perennially and intermittently flowing rivers and streams, also, periodically, flooded lake and reservoir shore areas, as well as lakes with stable water levels with characteristic vegetation. This habitat is transitional between true bottom land wetlands and upland terrestrial habitats and, while associated with water courses, may extend inland for considerable distances. Soils of the riparian habitat may not exhibit typical wet soil characteristics of other wetlands. If not, wet soil characteristics will exist close enough to the surface for the water to be used directly by vegetation. This vegetation may range from water-loving hydrophytes (such as pond weeds) through terrestrial forms (such as sycamores, cottonwoods, and willows).

The following is a summary of the floodplain and wetland-riparian Bureau policies which shows some of the similarities of the programs.

Floodplains	Wetland-Riparian Area
A. Avoid direct or indirect support of floodplain development.	A. Avoid adversely impacting wetland riparian areas.
B. Avoid adverse impacting of floodplain areas.	B. Avoid construction in wetland -riparian areas whenever practical alternative.
C. Minimize harm in actions adversely impacting floodplains.	C. Preserve and enhance natural and beneficial values.
D. Retain BLM floodplains unless they will be protected or required by law.	D. Minimize harm in actions adversely impacting wetland-riparian areas.
E. Monitor actions to ensure incorporation of floodplain objectives.	E. Retain BLM wetland-riparian lands unless they will be protected or required by law.

The Water Resources Council who must evaluate the various agencies procedures and effectiveness in complying with Floodplain Executive Order has held several technical seminars on floodplains and wetlands. These seminars and related information put out by them present means of accomplishing the intentions of the executive orders. Their basic guidelines for floodplain management give a detailed breakdown of E.O. 11988 (43 FR 6030, February 10, 1978).

A summary of one set of the technical seminars is given in BLM W.O. Information Memo 79-177 (April 25, 1979). This memo presents major differences of the orders, major biological and functional differences, further clarification on the definitions, actions having major adverse impacts, specific concerns to be addressed, and land acquisition.

Some of the major differences between the executive orders given in the above should also be noted. The two orders are different and the areas are different, but where overlay occurs, implementation of the orders should be coordinated to eliminate duplication where possible. The floodplain's order refers to all lands concerning Federal action while the wetland's order is basically a Federal land management order. The wetland's order stressed biological and environmental values with emphasis on protection, restoration and management while the floodplain's order stresses all beneficial values and functions with emphasis including protection of human life safety, welfare and reduction of flood losses.

IMPLEMENTATION OF E.O. 11988 and E.O. 11990

The attached outline section will present the basic implementation procedures desired by the executive orders. The information presented is taken from a Water Resources Council presentation for floodplain management as desired in their guidelines (43 FR 6030 February 10, 1978). The procedures for wetlands are very similar (the BLM manual and draft manual procedures are presently the same concerning the review and public involvement procedures).

BASIC REQUIREMENTS

- Identify whether their proposals are located in or affect the floodplain.
- If so, avoid the floodplain where practicable.
- Mitigate impacts if avoidance cannot be achieved.
- Involve the public in the floodplain management decision-making process.

EIGHT-STEP DECISION-MAKING PROCESS

1. Determine if action is in a floodplain.
2. Involve public in decision-making process.

3. Determine if there is a practicable alternative.

4. Identify impacts and support of development.

5. Mitigate adverse impacts and support.

6. Re-evaluate alternatives.

7. Announce and explain decision to the public.

8. Implement action with appropriate mitigation.

KEY ISSUES

- Is the action in or affecting the floodplain?

- What floodplain data should be used?

- To what use will the data be put?

- Where and how can such data be secured?

Critical Actions (Critical 500-year Floodplain):

- Those used by occupants who are relatively immobile (or cannot be moved quickly).
    - e.g. hospitals, nursing homes, schools, etc.
- Uses that must maintain operability during flooding.
    - e.g., power generation plants, water supply facilities, fire houses, ambulance services, etc.
- Storage of volatile, toxic or water-reactive chemicals.
    - e.g., liquid natural gas storage facilities, petrochemical tank farms, etc.
- Storage of essential or irreplaceable records.
    - e.g., archives, data processing storage facilities, etc.

PUBLIC NOTICE REQUIREMENTS

- Adequate information about the project when first proposed.

- Opportunity for review and comment.

- Account for rationale behind actions in or affecting floodplains.

Inform Public That:

- You have determined that action is in floodplain.
- You intend to analyze alternatives.
- If no practicable alternative, you will:
    - Assess impacts of action,
    - Identify measures to mitigate adverse impacts.

Early Public Notice Determinations:

- Audience to be reached.
    - (Federal, State, Local Agencies, Public Interest Groups, etc.)
- Vehicles to be used.
    - (Public Hearings, Federal Register, Local Newspapers, etc.).
- Number of repetitions.

Nature of Notice Depends On:

- Scale of the action.
- Potential for controversy.
- Degree of public need for the action.
- Number of affected agencies and individuals.
- Anticipated potential impact of the action.

PRACTICABILITY: BALANCING PROCESS

Need to Locate in the Floodplain vs. Requirements to:

- Avoid direct or indirect support of floodplain development.
    - Reduce risk of flood loss.
    - Minimize impact of floods on human safety, health and welfare.
    - Restore and preserve floodplain values.

Practicable Alternatives:

- Carrying out the proposed action at a location outside the floodplain (alternative site).

- Other means which accomplish the same purpose as the proposed action (alternative action).

- No action.

Practicability:

"Capable of being done within existing Constraints"

- The test of practicability:
    - Depends upon the situation,
    - Includes a consideration of pertinent factors such as:
        - Environment, Cost, and Technology.

Factors Determining Practicability:

- Natural environment (topography, habitat, hazards, etc.).
- Social concerns (aesthetics, historical and cultural values, land use patterns, etc.).
- Economic aspects (costs of space, construction, services and relocation).
- Legal constraints (deeds, leases, etc.).

IDENTIFY IMPACTS AND SUPPORT OF DEVELOPMENT

Floodplain Values:

- Water resource values:
    - Natural moderation of floods,
    - Water quality maintenance,
    - Ground water recharge.
- Living resource values:
    - Fish and wildlife,
    - Biological productivity.
- Cultural Resource Values:
    - Archeological and historic sites,
    - Open space:
        - Recreation and green belts.
- Agricultural, Acquacultural and Forestry Resource Values

Characteristics of Risk:

- Depth of floodwater.
- Velocity of floodwater.
- Rate of rise of floodwater.

- Location in a high risk area (floodway or high hazard area).
- Available warning and evacuation time.
- Special problems:
  - Flood related erosion, subsidence, sinkholes, combination of sources.

What is support of floodplain development?

- Allow, encourage, serve or otherwise facilitate floodplain development.
- Direct support results from actions within floodplains.
- Indirect support results from actions outside of floodplains.

MITIGATION

Requirements:

- Minimization of harm to lives, property, and natural values.

- Restoration and preservation of natural values

Definitions:

- Minimize - to reduce to the smallest possible amount or degree.

- Restore - to re-establish a setting or environment in which the natural functions of the floodplain can again operate.

- Preserve - to prevent modification to the natural floodplain environment or to maintain it as closely as possible to its natural state.

FINDING AND PUBLIC EXPLANATION

- Informs public of final decision.

- Post-decisional and pre-action notification.

Audience:

- A-95 Clearinghouse (if applicable).
- FEIS audience (if "major Federal action").
- Audience for the early public notice.

Vehicle:

- A-95 Clearinghouse (if applicable).
- FEIS (if "major Federal action").
- Vehicles used for early public notice.

Contents (Clearinghouse Notification):

- Statement of intent.
- Map of the site.
- Reasons for locating in the floodplain.
- Description of significant facts including alternatives considered.
- Conformance with state or local standards.

Contents (Public Notice):

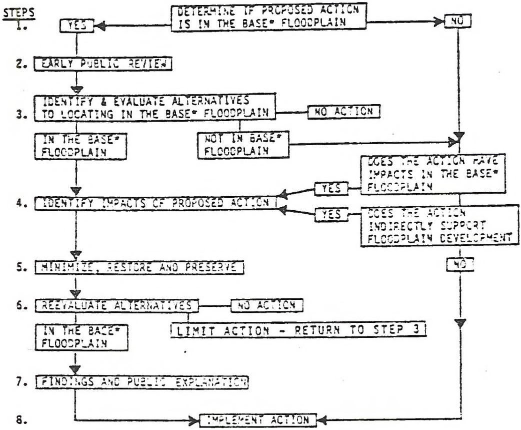
- Time period for public comments.
- Reasons for locating in floodplain.
- Description of facts considered for proposed action and alternatives. (Nature and degree of risk and natural values present.)
- Description of how the action affects natural or beneficial floodplain functions.
- Description of how the action is designed to minimize harm, restore, and protect the floodplain. (Mitigation and review of implementation.)
- Statement as to conformance to state and local floodplain protection standards.
- Statement of others involved and of concerns expressed.

IMPLEMENTATION

- Ensure appropriate implementation:
    - Review, audit, or monitor implementation.
    - Focus is on mitigation.
    - Integrate into existing review processes.

DECISION-MAKING PROCESS FOR E.O. 11988

FIGURE 1


STEPS
1.
YES
DETERMINE IF PROPOSED ACTION IS IN THE BASE* FLOODPLAIN
NO
2.
EARLY PUBLIC REVIEW
3.
IDENTIFY & EVALUATE ALTERNATIVES TO LOCATING IN THE BASE* FLOODPLAIN
NO ACTION
IN THE BASE* FLOODPLAIN
NOT IN BASE* FLOODPLAIN
DOES THE ACTION HAVE IMPACTS IN THE BASE* FLOODPLAIN
YES
4.
IDENTIFY IMPACTS OF PROPOSED ACTION
YES
DOES THE ACTION INDIRECTLY SUPPORT FLOODPLAIN DEVELOPMENT
NO
5.
MINIMIZE, RESTORE AND PRESERVE
6.
REEVALUATE ALTERNATIVES
NO ACTION
IN THE BASE* FLOODPLAIN
LIMIT ACTION - RETURN TO STEP 3
7.
FINDINGS AND PUBLIC EXPLANATION
8.
IMPLEMENT ACTION

* FOR CRITICAL ACTIONS SUBSTITUTE "500 YEAR" FOR "BASE".

FLOODPLAIN INFORMATION AND ASSISTANCE

Floodplain programs in developed areas have been extensively documented and analyzed because of the National Flood Insurance Act of 1968, as amended (42 USC 4001 et seq.) and the Flood Disaster Protection Act of 1973 (P.L. 93-234). The many floodplain studies have mapped most of the streams in developed areas and created alot of available flood information. In doing these studies, alot of methodologies and computer programs have been developed along with alot of people better equipped to do basic analyses than BLM is equipped to do. Therefore, in our initial BLM floodplain analyses, check around for available information and utilize the agencies that have the established floodplain information programs as best as you can.

The following agencies are involved in floodplain management and coordination or can assist with floodplain information:

	Locating	Technical	Regulatory	Management
Corps of Engineers	X	X	X	X
NOAA		X		
FHA/FIA	X	X	X	
FS	X	X		X
SCS	X	X		
BLM	X	X		X
BR	X	X	X	X
FWS		X		X
GS		X		
IDL			X	
IDT		X		
IDWR	X	X	X	
IWRI (U of I)		X		

WETLAND-RIPARIAN AREA MANUAL

The wetlands programs are not as far as advanced as the floodplains because of the many earlier national floodplain programs. The wetland-riparian program is now being emphasized because much of these areas have been destroyed and their biological are seen to be reaching a critical stage.

A draft manual has been developed and is in a final review process. The manual defines the basic responsibilities, policy and basic procedures very much like the floodplains manual. The last two sections concerning management of the wetland-riparian area are outlined below as to content to aid insight into the perceived areas of concern.

.2 Wetland-Riparian Habitat Management

  .21 Wildlife Activity Plans (HMP's)

  .22 Major Management Practices
    A. Buffer Strips (75 feet or greater)
    B. ACEC
    C. Withdrawals

  .23 Other Program Management Practices
    A. Grazing
    B. Forestry
    C. Minerals
    D. Fire
    E. Recreation

.3 Development, Construction, and Maintenance Activities

  .31 Road and Trail Construction
  .32 Channel Modification
  .33 Spring Development and Maintenance
  .34 Reservoir Construction and Maintenance
  .35 Land Treatment

SUMMARY

The floodplain and wetland programs are being emphasized by the executive orders because of past indifference to these lands. The procedures express a need for public involvement. The lands the order apply to often overlap and there are potential conflicts between the management methods. There is an implication, also, that on Federal lands, wetland values would be emphasized over other land values except where human safety is involved.

ACKNOWLEDGEMENT

Draft BLM information was supplied by Karl Gebhardt (ISO) and the Water Resource Council presentation information was provided by Tim Maywalt (WRC).

RIPARIAN HABITAT MANAGEMENT

Osborne Casey - State Fisheries Biologist
Nevada State Office, BLM
(Notes from presentation)

We need to educate the land manager in riparian habitat management. There is a tremendous variability in riparian areas and this should be pointed out.

Good fishery management is really good watershed management and there shouldn't be any conflict.

Many intangible values exist that need description.

The highest and best values of the riparian areas may not be met under many management strategies.

Management of riparian areas is a site specific problem.

Fencing is a tool to solving problem, but is not a final solution.

Overuse makes vegetation more susceptible to natural problems such as frost.

The Oregon SO has a slide presentation available concerning riparian areas and their values. It has been well received.

Why not manage year to year for proper utilization by limiting use?

The "How-to" is the big problem with riparian management. There is a real lack of effort to properly manage these areas.

Reynolds Creek Research Summary Relating to Land Management Actions - Don Brackensiek - Location Leader; Science & Education Administration, Boise, Idaho (edited)

The Reynolds Creek Watershed is a long-term research project involving an entire watershed near Boise, Idaho. The project has produced many publications and data concerned with watershed management. The staff at Reynolds Creek is interested in helping you with your watershed problems and questions. Please feel free to contact the following individuals:

Don Brackensiek - Location Leader
Cliff Johnson - Hydrologist (sediment & runoff)
Clayton Hansen - Hydrologist (climatology)
Gordon Stephenson - Geologist (Water quality)

Phone Numbers: 208-334-1363
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Reynolds Creek Watershed Research Unit - SEA
1175 S. Orchard
Suite 116, Patti Plaza
Boise, Idaho 83705

Yearly summaries of Reynolds Creek research available through the Denver Service Center or the above address.

Also, the workplan for the coming year is in preparation. If you wish to have input, please contact Eric Janes at DSC, FTS: 234-2374.

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HYDROLOGIC IMPACT OF GRAZING SYSTEMS ON INFILTRATION AND RUNOFF: DEVELOPMENT OF A MODEL

Introduction

Setting

Grazing is a widely applied use of the vast wildland resources in the western United States. Cattle and sheep (and other domestic and wild animals) have been grazed since early settlement, but concern for any consequent hydrologic impact did not begin until about 1930. In quantitative, routine, predictive terms, little is known, and the applied hydrology techniques are both primitive and poorly founded.

In these times, rangeland management, in the name of environmental impact, is expected to incorporate both on and off-site hydrology considerations, such as erosion, nonpoint pollution, water production, and flood potential. The overall goal on rangelands is usually to use the meager water supply on site, as infiltrated waters are used to grow forage. From the plant production standpoint, runoff water is wasted. On semiarid lands, it is generally of low volume and poor quality as well.

Hydrologic Nature of Rangelands

Because of their common environmental inputs and land use, rangelands tend towards a series of common hydrologic characteristics. They are somewhat different than agricultural lands, forest lands, or urban lands, although there certainly are overlaps in characteristics, and the distinctions are neither exclusive nor completely consistent.

In general (especially in the western U.S.), rangelands are of low precipitation, sparse cover, sometimes saline, with variable soils, and undergo a regular diffuse harvest. Classical overland flow from rainstorms, found to be infrequent on most forested lands, seems to occur with more regularity on grazing lands. A summary contrasting forest and range lands is found in Table 1.

Grazing Systems

Because the forage resources on rangelands are generally diffuse and of low unit (e.g. per acre) value, they cannot be economically intensively managed, or harvested as a field of corn might. The cattle or sheep play the role of intermediate consumers, converting the forage to meat, which in turn is harvested. One of the few choices available to the manager is where and when to put the cattle, and for how long.

In recent years, schemes of staggered and/or irregular grazing patterns have come into popularity, with the expected benefits of increased forage production and improved plant composition. These systems are designed according to local conditions and feature recurring periods of grazing and deferment on two or more land units. Some specific patterns within the generic classification are: continuous grazing, deferred grazing, deferred-rotation grazing, and rest-rotation grazing. A detailed review of these systems is given by Hickey (12). However, there is essentially no coherent body of knowledge on the hydrologic impacts of these systems, although Gifford and Hawkins (7) reviewed some of the component problems.

Objectives

In response to the above conditions, the proposed objectives of this research were as follows:

1. To develop a model for use in determining the hydrologic impact of grazing systems on infiltration and runoff. The model will be derived primarily from synthesis of available published and unpublished literature.

2. To utilize the model in a variety of sensitivity tests to ultimately outline model limitations, to define research needs, for recommending land management guidelines, and for evaluating environmental impact.

3. To provide the model in a readily usable and understandable form for direct application by the land manager (perhaps through an instruction manual as well as actual demonstration to field personnel).

Model Development

The model is developed in three fairly distinct steps: 1) Definition of grazing system components in intensity terms; 2) relating grazing intensity to infiltration; 3) assembly of a time dependent prediction model.

Table 1. Generalized and idealized contrasts between natural forest and range conditions.

Item	Range	Forest
Precipitation:		
Annual depth	Low to moderate	Moderate to high
Form	Rainfall is often entire water supply	May include rain and snow
Intensities	High, short duration	Longer durations, ground intensities modified by cover
Snow	May be absent	Often a significant role
Soil Surface Properties:		
Surface texture	Fine/medium	Coarser
Depth	Shallow	Deep
Presence of pans	Sometimes	Seldom
Organic matter	Low, poorly incorporated	Well humified
General development	Poorly developed, accumulation horizons grass and/or shrubs	Well developed leached horizons, trees and grass and understory vegetation
Ground Cover	Often sparse	Seldom sparse
Intercepting canopies	Single	Often multiple
Runoff and Hydrology:		
Infiltration rates	Low	High
Overland flow	Common during rainstorms	Rare
Base flow	Seldom, intermittent	Typical condition
Permanent stream	Absent or intermittent	Common
Water quality	Often salty, warm, etc.	Usually good quality
Sediment	High natural erosion	Low natural erosion High if aggravated
Harvest Pattern:	Consistent diffuse annual harvest	Sporadic, occasional harvest at rotation
Initial Conditions:		
Soil Moisture	Low	Variable
Groundwater	None	None or some
Channel surface area	None	Small, but often present

Source: Riley & Hawkins (17).

Interpretation of Grazing Systems

Grazing systems may be described in terms of duration and intensity of grazing on a single representative pasture, and the intervals between.

Grazing Intensity. Grazing intensity may be envisioned as a rate of utilization of range forage. The term conveys an image of rapidity of use or grazing pressure, although this is not entirely correct. It is merely an adjectival classification based on the fraction of the current year's growth of index species that are utilized. Over a long period of time, it is related to the general health or vigor of these index or key species and to the site and vegetative community as a whole. Any grazing activity may thus be described in intensity terms. The classifications of "heavy," "moderate," "light," and "ungrazed" are commonly used. Table 2 gives example utilization rates and intensity descriptors which have been used by the U.S. Forest Service. Figure 1 gives a graphical illustration of the meaning of grazing intensity.

Table 2. Example utilization and grazing intensity.

Key Species Utilization (%)	Grazing Intensity
0 - 5	Ungrazed
6 - 20	Light
21 - 40	Moderate
41 - 65	Heavy
Over 65	"Unacceptable"

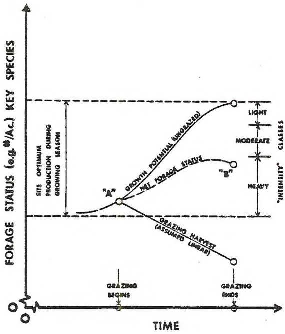
FORAGE STATUS (e.g. #/Ac.) KEY SPECIES
SITE OPTIMUM PRODUCTION DURING GROWING SEASON
"A"
"B"
GROWTH POTENTIAL (UNGRAZED)
NET FORAGE STATUS
GRAZING HARVEST (ASSUMED LINEAR)
LIGHT
MODERATE
HEAVY
"INTENSITY" CLASSES
GRAZING BEGINS
GRAZING ENDS
0
0
TIME

Figure 1. Grahical representation of grazing intensity, for an example situation. Note that the intensity is defined on the fraction of key species forage growth consumed over the duration of the activity, regardless of the interim status. The path taken from A to B is unimportant. Boundary levels between the intensity classes are chosen locally, as are the key species, both on range ecology considerations.

The notion of "key species" arises from the need to monitor and identify range forage utilization in a compact but meaningful form. Thus, key species are chosen on the basis of their role in consumption patterns, and as suitable as an indicator for the general ecologic health of the grazing lands. The key species are usually the most important forage species on the range, and form the bulk of the forage consumed. They are different for different animals, and for different land conditions; and thus must be locally identified.

Pasture Intensities. The intensity imposed on each unit during its turn in a grazing system may be inferred from the prescription. No grazing or "rest" is, of course, at an "ungrazed" intensity. A normal turn on a multiple pasture system may only be interpreted as "heavy" grazing, insofar as the intent is to uniformly remove a large fraction of the available forage. Intermediate actions are taken as either "moderate" or "light" grazing, as appropriate.

Representative Pastures. A multiple pasture scheme will have a variety of grazing activities progressing simultaneously on different units, and cycling over a number of years. Ideally an N-unit scheme will repeat over N years. Thus, for purposes of hydrologic analysis, any pasture in the system may be taken as a sample, and its dynamics studied intensively. This approach does require the assumption of equivalent sites.

Example. A representative grazing scheme as taken from a real situation is shown in Table 3. Note that all grazing activities have been classified into intensity descriptions. This example will be used in subsequent development.

Table 3. Noland Gulch grazing plan, Saguache County, Colorado.

From	To	Duration (yr)	Activity
30 Sep	1 Jun	1.67	Rest
1 Jun	1 Aug	0.17	Graze Heavy
1 Aug	30 Sep	0.17	Graze Moderate
30 Sep	1 Aug	0.82	Rest
1 Aug	30 Sep	0.17	Graze Moderate
	TOTAL	3.00	

Source: San Luis Valley EIS (Gifford, Hawkins, and Williams, 6).

Data Assembly

Grazing Intensity and Infiltration Rates. Studies relating grazing practices directly to runoff are rare, insofar as interest is mainly in recharging soil moisture to grow forage in rain-scarce environments. The studies which have been completed concentrate on infiltration. Thus, there exists a modest literature on infiltration (as an indicator of land hydrology). Unfortunately, this information presents several different descriptors of infiltration, and is measured with a variety of instruments.

The most meaningful infiltration parameter, and perhaps the most consistent as well, is the residual constant rate experienced at the end of a long storm. It is represented as f_c in the well-known Horton equation.

$$f = f_c + (f_o - f_c) \exp(-kt) \quad . \quad . \quad . \quad (1)$$

It (f_c) represents the gravitational component in the infiltration process and is equivalent to the saturated permeability, k, of the impeding layer. In most field situations, the observed infiltration rate, variable with time, approaches the final rate f_c after modest time frames, i.e., 20-40 minutes. Thus for long storms of (say) 6, 12, or 24 hours, f_c predominates over most storm duration.

Ideally, infiltration measurement should be carried out using rainfall, either natural or simulated, and calculated as the difference between input rainfall and output runoff. As a refinement, accounting may also be made for initial surface detention and temporary storage as well. Flooding infiltrometers are also used, but represent unnatural conditions: exceptionally high infiltration estimates result owing to the ponded head of water.

A summary (8) of all available infiltration studies on grazing lands was scanned to excerpt only that data which meets the following conditions: 1) Terminal rates; an estimate of f_c; 2) measured with either natural rainfall or a sprinkling infiltrometer; and 3) identifies grazing intensity. This extracted listing is given in Table 4.

Table 4. Infiltration data used in grazing intensity analysis.

Reference, Soils, and Location	Grazing Intensity			
	Ungrazed	Light	Moderate	Heavy
Branson et al., 1962 (1)	0.5	0.1		0.2
'Slick' or 'Semislick' Soils, Montana	0.1			0.3
	0.3	0.5		0.3
	2.6	1.5		0.6
	0.4	0.2		0.6
		0.3		0.3
	0.4	0.1		0.5
	1.5	1.5		0.4
	2.3		1.9	
Gifford et al., 1976 (10)	2.6		2.3	
Sandy Loam Soils, Utah	2.9		2.4	
	2.5		2.6	
	2.5		1.6	
	1.3		1.3	
	1.5		1.2	
	1.4		1.9	
	2.0		1.2	
	1.4		1.8	
	1.1		1.0	
Dortignac and Love, 1961 (2)	2.0			
Granitic Alluvium, Colorado	2.3	0.9	1.2	1.2
	3.3	1.3	1.4	0.8
	1.6			
	2.9	1.5	1.6	1.8
	2.6	1.8	2.3	0.8
Rauzi and Smith, 1973 (16)		1.8	2.0	0.8
Sandy Loams, and Loams, Colorado		1.0	0.9	1.0
		1.8	2.2	1.2
Thompson, 1968 (18)	0.7		0.8	
Shale Derived Soils, Colorado	0.9		1.1	
	0.7		0.8	
Rauzi, 1956 (15)		1.2		0.9
Silt Loam, Wyoming				
Gifford (unpublished) (4)	1.7		1.4	
Silty Loam, Idaho	1.6		1.4	
	1.1		0.9	
	1.3		0.9	
Rauzi, 1954 (13)	1.3	1.7	1.3	1.2
Silt Loam, Wyoming	1.2			0.7
Rauzi, 1955 (14)	1.2	1.2	1.3	1.2
Fine Gravelly Loams and Silt Loams, Wyoming	1.5	1.5	1.4	1.2
N	35	18	28	20
Mean	1.58	1.11	1.50	0.80
Standard Deviation	0.82	0.60	0.51	0.41

Notes: All rates in inches per hour. Grazing intensity as judged locally in each study.

Table 5. Results of paired data analysis: infiltration rates (in/hr) associated with grazing intensities.

Grazing Intensities				N^a	"t"	P(%)
Ungrazed	Light	Moderate	Heavy			
1.60(1.00)	1.06(0.60)			13	2.64	97.9
1.79(0.73)		1.48(0.50)		25	2.79	99.0
1.47(1.01)			0.79(0.43)	15	3.06	99.1
	1.43(0.32)	1.56(0.44)		10	-1.32	78.0^b
	1.10(0.61)		0.82(0.42)	17	2.16	95.3
		1.45(0.44)	1.12(0.29)	10	2.32	95.5
1.62(0.82)	1.30(0.61)*			31	3.21	99.7
	1.13(0.64)*		0.82(0.42)	17	2.28	96.1

Notes: Table shows the mean infiltration rate in inches per hour with the standard deviation in parentheses. "t" statistic calculated by paired difference test. P is the probability in percent associated with the "t" statistic (two tailed test). Starred (*) items are for light and moderate combined data.

[a] "N" is the number of cases shown in Table 4. For example there were 13 matched pairs of "ungrazed" and "light" intensities.

[b] Taken as not being a significant difference.

Comparisons. The convenient data summary in Table 4 permits comparison of infiltration rates by grazing intensity. The means and standard deviations of the raw data are shown summarized in Table 4. Because of the differences in sites, sample sizes, etc., they are only of descriptive value.

More appropriate comparisons can be made by paired data tests, i.e., two associated values using a paired t test. The results for the six combinations of two intensities are shown in Table 5. Note that there was no significant difference between observed rates under "moderate" and "light" grazing, thus these data are combined in a final test shown in the bottom two lines of Table 5. This merging is continued through the remainder of this work. As a general statement, there is a difference in infiltration rates associated with the three grazing intensities. This is summarized in Table 6, with values approximated from Table 5.

Regression Relationships. The observed infiltration rates in Table 4 may now be related by statistical regression, again using the three categories of ungrazed, light - moderate, and heavy. Where the values of both light and moderate were available, they were averaged, otherwise the available single value was used as "light - moderate." The results are shown in Table 7, with least squares solutions for each grazing intensity. Two representative plots are shown in Figures 2 and 3.

Table 6. General infiltration rates (f_c) by grazing intensity.

Intensity	f_c (in/hr)
Ungrazed	1.60
Light/Moderate	1.25
Heavy	0.80

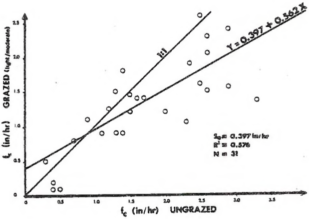

Figure 2. Regression relationships between ungrazed and grazed infiltration rates.

Recovery Relationship. Several data sets in Table 4 include infiltration measurements over time during prolonged rest periods following grazing. Both intuition and reason suggest that infiltration should "recover," i.e., increase with time following the removal of grazing pressures. Figures 4 through 6 show areas bracketing these changes from observations on grasslands, Ponderosa pine grasslands, and for Mancos shale badlands. The information is coarse, and only broad bands are shown; there is an apparent recovery on both of the grassland sites. The

Table 7. Summary of least squares regression equations between infiltration rates at different grazing-intensities. All in in/hr.

1. Heavy and Moderate/Light:	$r = 0.573$	$N = 17$
$f_h = 0.405 + 0.375\ f_{m/1}$	$f_{m/1} = 0.405 + 0.877\ f_h$	
$S_e = 0.345$ in/hr	$S_e = 0.528$ in/hr	
2. Heavy and Ungrazed:	$r = 0.573$	$N = 15$
$f_h = 0.423 + 0.247\ f_u$	$f_u = 0.427 + 1.330\ f_h$	
$S_e = 0.356$ in/hr	$S_e = 0.828$ in/hr	
3. Ungrazed and Mod./Light	$r = 0.759$	$N = 31$
$f_u = 0.281 + 1.025\ f_{m/1}$	$f_{m/1} = 0.397 + 0.562\ f_u$	
$S_e = 0.536$ in/hr	$S_e = 0.397$ in/hr	

Note: Above pairs are least squares solutions from data; not inverse algebraic solutions.

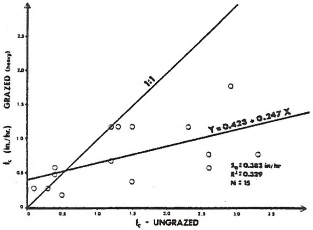

Figure 3. Regression relationships between ungrazed and grazed infiltration rates.

first (Figure 4) shows recovery continuing after 13 years, while the Ponderosa pine grassland data suggests about an 8-year recovery period. The Mancos shale site data suggest either 1) no recovery, or 2) no original impact.

Model Synthesis

The background material developed thus far provides a basis for modeling the march of infiltration capacity with time for a representative pasture. The synthesis of the grazing intensity impacts combines the statistical relationships revealed in Table 7 with assumptions of 1) a "target rate" for each intensity, 2) linear impact, and 3) linear recovery.

Assumptions. First, the specific infiltration rates identified by design grazing intensities provide boundaries between which

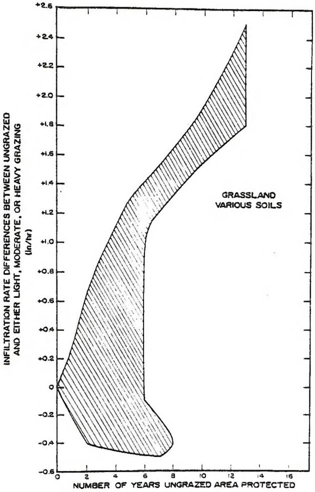

Figure 4. Infiltration recovery for grasslands. Source: Gifford and Hawkins (8).

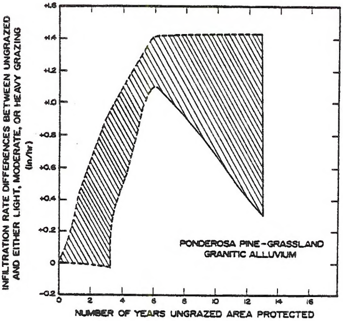

Figure 5. Infiltration recovery for Ponderosa pine grasslands. Source: Gifford an Hawkins (8).

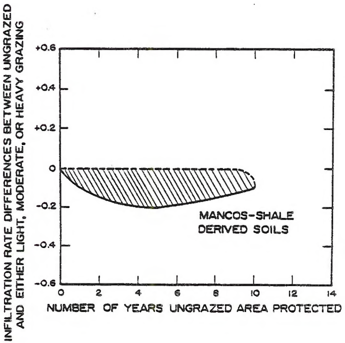

Figure 6. Infiltration recovery for Mancos shale derived soils. Source: Gifford and Hawkins (8).

all occasions must fall, and targets towards which rates will respond according to the applied grazing intensities. These rates are defined by the equations given in Table 7 on the basis of the current infiltration status and grazing intensity (both user supplied).

Second, response to impacts (a target reduction in infiltration) is assumed to occur linearly with time and in entirety over the grazing activity duration. Although this does not violate the literature findings, it arises largely by default and a deficit of contrary information. There are no studies known that deal with the time dimension of grazing-infiltration impacts.

Third, recovery (a targeted increase in infiltration) is assumed to occur linearly over a characteristic recovery time, T. Some perspective on this may be gained from the recovery studies discussed previously. Rest for less than the recovery time will result in proportionate restoration of the infiltration rate deficit. There will be no recovery past the target rate. In functional form, the recovery relationship would thereby be

$$f = f_p + (f_t - f_p)\ (t/T_r); \quad 0 \leq t \leq T \quad . \quad . \quad (2)$$

where f is infiltration rate, and the subscripts "p" and "t" signify present and target conditions, t is the duration of the current recovery period, and T_r is the characteristic recovery time.

Procedure. The model then proceeds sequentially to represent infiltration being impacted by and recovering from grazing according to the above rules, and as outlined in the following steps:

1. The grazing system to be evaluated is defined in terms of grazing intensities and durations.

2. Given an initial infiltration rate and grazing intensity, target rates for all intensities are calculated from the appropriate equations in Table 7.

3. The effects of the grazing activities during the first time element are calculated. If an impact (a targeted reduction in infiltration) the rate is reduced to the target rate linearly over the duration of the grazing. If a recovery (a targeted increase in infiltration) it occurs linearly in accordance with Equation 2.

4. The output infiltration from step 3 is used as the input for the next grazing period, again following the same rules. This is repeated for all periods throughout the cycle. The output is a matrix of times and infiltration rates.

5. The procedure is repeated over several cycles until an equilibrium status

results; that is, when the initial rate at the beginning of the cycle equals the final rate at the end of the cycle. This usually occurs after two cycles.

6. As desired, either average overall infiltration rates or average seasonal (summer rainstorm) rates, or both, may be calculated and used in evaluating hydrologic response.

The general procedure is given in flow chart form in Figure 7, and an example with notes is given in the following section.

Example. A range site is currently under moderate grazing intensity and is found to have an infiltration rate of 1.00/hr. A grazing system as shown in Table 3 is proposed. A recovery time, T_r, of 4.0 years is chosen.

1. Knowing that $f_{m/l}$ is 1.00 in/hr, f_u and f_h are found from the equations in Table 7 to be

$$f_u = 1.31 \text{ in/hr}$$
$$f_h = 0.78 \text{ in/hr}$$

These three values comprise the target infiltration rates, and f_u and f_h are boundaries between which all values must fall.

2. The first period is 1.67 yrs of rest. Thus f will recover 1.67/4 of the difference between its present value (1.00 in/hr) and the ungrazed target (1.31 in/hr), or

$$f = 1.00+(1.31-1.00)(1.67/4)x1.13 \text{ in/hr})$$

3. The second period is 0.17 yr of heavy grazing. The impact is felt linearly over the 0.17 year. The infiltration rate is f_h = 0.78 in/hr.

4. The third period is 0.17 yr of moderate grazing. This is a recovery situation, as the target infiltration rate (1.00 in/hr) is greater than the present rate (0.78/hr). Thus:

$$f = 0.78+(1.00-0.78)(0.17/4) = 0.79 \text{ in/hr}$$

5. The fourth period is 0.82 yr of rest, again a recovery situation. The infiltration rate at the end of this period is:

$$f = 0.79+(1.31-0.79)(0.82/4) = 0.90 \text{ in/hr}$$

6. The final period in the cycle in 0.17 yr of moderate grazing, which is again a recovery:

$$f = 0.90+(1.00-0.90)(0.17/4) = 0.90+\text{in/hr}$$

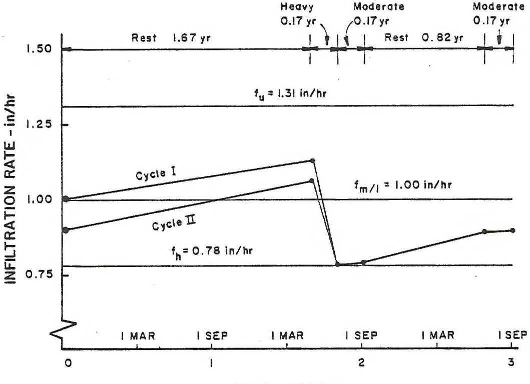

Figure 7. Modeled infiltration rates for the Noland Gulch example. Saguache County, Colorado.

In this case, the recovery is too small (0.004 in/hr) to show with rounding to two decimal places.

One cycle has now been simulated. A second is computed using the last period output (0.90 in/hr) as the input to the first period of the second cycle. The second cycle is stable: the final rate is equal to the initial rate. The results are summarized in Table 8 and shown graphically in Figure 7.

From the stable cycle, average rates for either the entire cycle or for a specific season (such as summer rainstorm periods) may be calculated. As shown in Table 8, these amount to 0.93 in/hr and 0.92 in/hr respectively for the example. These may be compared to those calculated under alternate grazing system proposals.

Model Operation and Use

Computer Program

The previously described logic is shown in flow chart form in Figure 8 and given in computer source language in Appendix B. The program was written in BASIC for a Wang 2200-S system. Storage requirements are minimal. It is easily translated into FORTRAN.

Usage

Input Information. The model uses only: 1) the grazing intensity pattern interpreted as periods of rest, moderate - light, and heavy grazing; a current status moderate - light infiltration rate; and 2) a characteristic recovery time.

The grazing scheme is a given input designed for forage and animal production goals. The definition of key species and the expected utilization levels will be determined by range management specialists. The grazing intensity interpretations shown draw from such local sources of technical advice as well.

The current grazing intensity is assumed as moderate - light. The infiltration rate for this status and site situation may be obtained by several means. Site testing with sprinkling infiltrometers is probably the most preferable alternate, if the time, equipment, and support are available. The summarized research results as shown in Gifford and Hawkins (8) may be used, guided by Table 4, as an estimate without field work. Also, if the user is inclined to use runoff curve numbers (CN) as a basis for land condition, equivalent ϕ-indexes may be estimated from the equation

$$CN = 1200/(12 + \phi T) \quad . \; . \; . \; . \; . \quad (3)$$

or

$$\phi = (12/T)(100/CN-1) \quad . \; . \; . \; . \; . \quad (4)$$

where ϕ is the net storm average loss rate (in/hr), T is the storm duration (hr) to be considered, and CN is the runoff curve number. The relationship springs from conservation of mass considerations (11).

The recovery time, T_r, plays an important role in the model, and must be estimated from the available site information and the background given in the three studies given

Table 8. Summary of model output for Noland Gulch grazing plan.

Date	Time (yr)		Activity	Inf. Rate (in/hr)	
	Cum.	Inc.		Cycle I	Cycle II
30 September	0			1.00	0.90
		1.67	Rest		
1 June	1.67			1.13	1.07
		0.17	Graze heavy		
1 August	1.84			0.78	0.78
		0.17	Graze moderate		
30 September	2.00			0.79	0.79
		0.82	Rest		
1 August	2.83			0.90	0.90
		0.17	Graze moderate		
30 September	3.00			0.90	0.90

Summary Rates: Rest: 1.31 in/hr
Mod. light: 1.00 in/hr
Heavy: 0.78 in/hr

Average Summer: 0.92 in/hr
(June 1 - September 1)
Average Annual: 0.93 in/hr

in Figures 5 through 7. As may be evident, background on this parameter is meager. However, the available information and intuition suggests rapid recoveries (low T_r) in moist porous sites with freezing and thawing, and slow recoveries (high T_r) in dry hostile environments.

Sensitivity

The model output, characterized by the stable cycle average infiltration rate is naturally influenced by the choice of the coefficients $f_{m/l}$ and T_r used. This influence has been determined for the Noland Gulch example, and depicted in Figures 9 and 10.

The chosen recovery time (T_r) may have a significant impact on the model outcome and on subsequent management decisions. As shown in Figure 9, using T_r less than about 2.5 years shows a net average hydrologic improvement, as shown by the average infiltration rate. All values over 2.5 years had a negative net impact, i.e., it reduced the infiltration rate as compared to a moderate/light continuous grazing system.

The effects of $f_{m/l}$ are also meaningful. First, a choice of $f_{m/l}$ less than 0.65 in/hr will indicate an improved infiltration rate under heavy grazing. This is perhaps possible on heavy soils: a number of physical explanations may be imagined. Second, higher levels of $f_{m/l}$ predicts increasing impacts

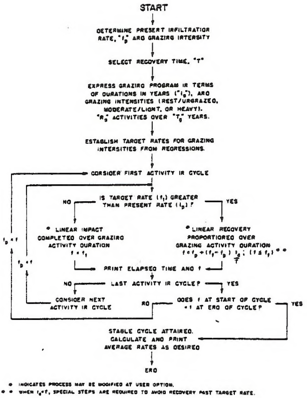
START
DETERMINE PRESENT INFILTRATION RATE, "f_p" AND GRAZING INTENSITY
SELECT RECOVERY TIME, "T"
EXPRESS GRAZING PROGRAM IN TERMS OF DURATIONS IN YEARS ("t_g"), AND GRAZING INTENSITIES (REST/UNGRAZED, MODERATE/LIGHT, OR HEAVY). "n_g" ACTIVITIES OVER "T_g" YEARS.
ESTABLISH TARGET RATES FOR GRAZING INTENSITIES FROM REGRESSIONS.
CONSIDER FIRST ACTIVITY IN CYCLE
IS TARGET RATE (f_t) GREATER THAN PRESENT RATE (f_p)?
NO
YES
* LINEAR IMPACT COMPLETED OVER GRAZING ACTIVITY DURATION $f = f_t$
* LINEAR RECOVERY PROPORTIONED OVER GRAZING ACTIVITY DURATION $f = f_p + (f_t - f_p)\frac{t_g}{T}$; $(f \le f_t)$ **
PRINT ELAPSED TIME AND f
LAST ACTIVITY IN CYCLE?
NO
YES
CONSIDER NEXT ACTIVITY IN CYCLE
DOES f AT START OF CYCLE = f AT END OF CYCLE?
NO
YES
$f_p = f$
$f_p = f$
STABLE CYCLE ATTAINED. CALCULATE AND PRINT AVERAGE RATES AS DESIRED
END
* INDICATES PROCESS MAY BE MODIFIED AT USER OPTION.
** WHEN $f_p = f$, SPECIAL STEPS ARE REQUIRED TO AVOID RECOVERY PAST TARGET RATE.

Figure 8. Flow chart description of the grazing impact model.

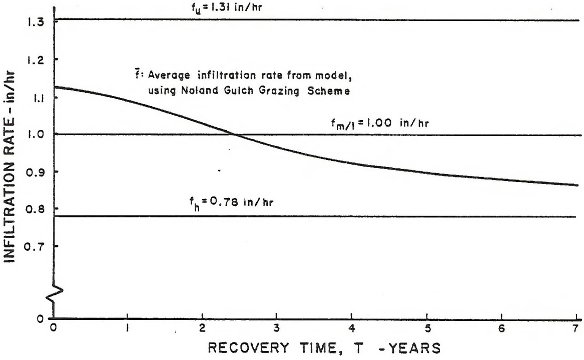

Figure 9. Modeled average infiltration rate as a function of assumed recovery time, T_r.

from the grazing system: $f_{m/l}$ grows greater, as shown in Figure 10.

Thus, model usage should incorporate the most realistic values of T_r and $f_{m/l}$ possible. Its use for "comparative results only" is influenced significantly by these parameters.

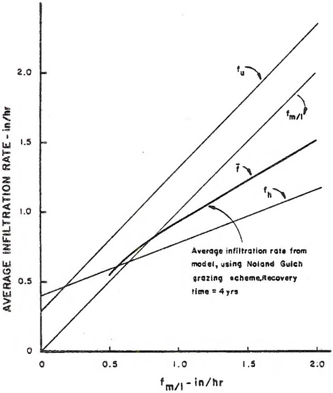

Figure 10. Modeled average infiltration rate as a function of assumed moderate-light infiltration rate.

Perspectives

As is common with model synthesis and usage, a number of problems, opportunities, and insights occur which raise additional issues. For enlightened professional application the user should be aware of these, and factor them into his judgment in choosing coefficients and assigning degrees of belief to the output for use in decision making.

Problems and Opportunities

Due to the limited amount of basic data, the parameters not evaluated in the literature, and the compromises used to make the model sufficiently simple to be usable, a number of processes were either ignored or only crudely approximated. Some of these are discussed in the following:

Seasonal Variation. The model makes no recognition of natural seasonal variation in infiltration, but rather assumes a straight line movement towards a target. Information on seasonal variation is in short supply, although Gifford (5) has noted a peak rate at mid-summer on rangelands in southeastern Utah.

Alternate Impact Paths. In the face of no better or contradictory evidence, the model assumes a simple linear impact over the duration of the grazing. However, it might also be reasonable to assume that the rate of impacting is linear with time. In differential form this may be expressed as

$$\frac{d(f - f_t)}{dt} = \text{constant} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

There are analogous reactions widespread throughout the physical and earth sciences: for example, Darcy's law, erosion equilibrium on disturbed sites, or fuel moisture dynamics. Solution of Equation 5 with appropriate boundary conditions leads to

$$f = f_p + (f_t - f_p)(1 - \exp(-t/\tau)) \quad . \quad (6)$$

where τ is a characteristic time constant, the time required for infiltration to move (1 - 1/e) or approximately 63 percent towards the final equilibrium status. This situation is more in keeping with both reason and intuition, but is completely unsupported by any known field data. Usage would require estimates of τ. Values from about 0.1 year (for sensitive situations) to about 1.0 year (for relatively insensitive environments) seem to be reasonable estimates.

Moderate Grazing Impacts. An option which might be exercised in specific situations would be to model no change with moderate grazing. This rule might be applied in response to the commonly held but undocumented belief that "moderate" land use is neither destructive nor beneficial to the environment. Such a rule change would undoubtedly affect the output of a grazing cycle run.

Alternate Recovery Paths. If the exponential impact formula (Equation 6) were used, it would only be consistent to model recovery likewise. This would result in rapid initial recovery and undoubtedly cause most heavy grazing impacts to appear less damaging.

Stochastic Considerations. The model as presented is deterministic; i.e., it makes no recognition of the random occurrence of influencing factors, such as interim rainfall. Thus, a touch of stochastic realism might be attained by casting seasonal or long term recovery or impact as a function of interim precipitation. The model has already been used by Fogel, Hekman, and Gilbert (3) with stochastically generated rainfalls imposed on output infiltration rates to provide a distributed array of design runoffs and erosion rates.

Future Work

The model could be improved by more credible background process models. To this end several critical research thrusts can be suggested.

Impact Paths. The temporal dynamics of recovery and impacts are obvious areas of present ignorance. This matter alone, remarkable for its vague current status, deserves primary attention if the model is to be seriously applied in the future.

Infiltration and Runoff. The model outputs only infiltration rates. Applied hydrology is usually oriented towards rainstorm runoff, and thus a linkage must be made between infiltration and runoff generating methodologies. The most popular rainstorm-runoff technology, the SCS curve number method, contains almost no means of translating infiltration rates to curve number. Likewise, plot infiltration rates, on which the model is based, are currently difficult to interpret on a watershed wide scale.

Estimating Infiltration. The assumed present infiltration rate is an important and sensitive input to the model. As described earlier, output, even on a comparative basis, is strongly influenced by this choice. It would be useful to be able to estimate this base rate from the soil, cover, and slope information usually available. There is no known methodology to make this estimate at present and thus either assumption or personal judgment plays a strong role.

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APPENDIX A

SYMBOLS

The following symbols are used (1 in = 2 cm).

f = final or long term infiltration rate (in/hr)

As subscripts on f:

p = at the beginning of a period ('present')

e = at end of a period

t = target

h = under heavy grazing intensity

m = under moderate grazing intensity

l = under light grazing intensity

u = under rest conditions ('ungrazed')

m/l = under moderate or light grazing intensity; combined because the two intensities are hydrologically indistinguishable based on constant or near-constant infiltration rates.

T_r = linear recovery time, years

t = activity period duration, years; also shown as t_a

τ = (tau) exponential recovery time constant, years

APPENDIX B

COMPUTER PROGRAM AND SAMPLE OUTPUT

```
10  COM A(50),T(50),F(4),B$(5)
20 REM ** A()=ACTIVITY.A()=1,HEAVY;A()=2,MOD/LT;A()=3,REST/UNG
30 REM ** T9=LINEAR RECOVERY TIME
40 REM ** T()=DURATION OF ACTIVITY,F(A(J))=TARGET INF RATE
50 B$(1)="!!HEAVY!!":B$(2)="MOD/LIGHT":B$(3)="REST/UNGR"
60 INPUT "PRESENT INF RATE, IPH",F(2)
70 INPUT "RECOVERY TIME,YR",T9
80 N=1:REM  INPUT GRAZING PLAN*********************
90 INPUT "ACTIVITY CODE",A(N)
100 IF A(N) [0 THEN 130
110 INPUT "              DURATION",T(N)
120 N=N+1 :GOTO 90
130 N=N-1:T2=0:FOR L=1TO N:T2=T2+T(L):NEXT L
150 REM CALCULATE TARGET RATES*********************
160 F(3)=.281+1.0251*F(2):F(1)=.4054+.3744*F(2)
170 T=0:S8=0:F=F(2)
180 PRINTUSING 190,T9
190%   RECOVERY TIME= ##.#YR
200 PRINTUSING 210,F(1),F(2),F(3):PRINT
210% F(1)= ##.###   F(2)= ##.###  F(3)=##.###
220PRINT "   ----TIME----                        -INF RATE:IPH- "
230 PRINTUSING 240:PRINTUSING 260
240%    BEGIN  END       ACTIVITY          BEGIN    END
250%   ##.##  ##.##  #########  #.##YR   ##.###  ##.###
260%==========================================================
270 REM OPERATE MODEL THROUGH GRAZING PLAN *******
280 FOR K= 1TO 2
290 IF K=1 THEN 300:PRINT
300 FOR J= 1 TO N
310 IF F(A(J))[=F THEN 330
320 GOSUB 440:GOTO 340:REM * * IMPACT * *
330 GOSUB 530:GOTO 340:REM !!!!RECOVERY!!!!
340 T=T+T(J)
350 PRINTUSING 250,(T-T(J)),T,B$(A(J)),T(J),F,F9
360 IF K=2 THEN 370 :GOTO 380
370 S8=S8+T(J)*((F+F9)/2)/T2
380 F=F9
390 NEXT J:NEXT K
400 PRINTUSING 260
410 PRINTUSING 420,S8
420%   AVG INF RATE = ##.####IN/HR
430 GOTO 560
440 REM  RECOVERY SUBROUTINE ****************
450 IF T(J)]T9 THEN 480
460 F9=F+(T(J)/T9)*(F(A(J))-F)
470 GOTO 520
480 T8=T9:T7=T(J)-T8
490 PRINTUSING 500,(T+T8),F(A(J))
500%           ##.###     ***COMPLETE RECOVERY**  ##.###
510 F9  =F(A(J))
520 RETURN
530 REM  IMPACT SUBROUTINE ******************
540 F9=F(A(J))
550 RETURN
560 STOP
```

```
  RECOVERY TIME=  4.0YR
F(1)=  0.779   F(2)=  1.000  F(3)= 1.306

  ----TIME----                          -INF RATE:IPH-
   BEGIN  END        ACTIVITY           BEGIN    END
==========================================================
    0.00    1.67  REST/UNGR  1.67YR     1.000    1.127
    1.67    1.84  !!HEAVY!!  0.17YR     1.127    0.779
    1.84    2.01  MOD/LIGHT  0.17YR     0.779    0.789
    2.01    2.83  REST/UNGR  0.82YR     0.789    0.895
    2.83    3.00  MOD/LIGHT  0.17YR     0.895    0.899

    3.00    4.67  REST/UNGR  1.67YR     0.899    1.069
    4.67    4.84  !!HEAVY!!  0.17YR     1.069    0.779
    4.84    5.01  MOD/LIGHT  0.17YR     0.779    0.789
    5.01    5.83  REST/UNGR  0.82YR     0.789    0.895
    5.83    6.00  MOD/LIGHT  0.17YR     0.895    0.899
==========================================================
  AVG INF RATE =  0.9258IN/HR
```

HYDROLOGIC IMPACT OF GRAZING SYSTEMS
ON INFILTRATION AND RUNOFF:
DEVELOPMENT OF A MODEL

by

Richard H. Hawkins
and
Gerald F. Gifford

Watershed Science Unit
College of Natural Resources
Utah State University

Hydrology and Hydraulics Series
UWRL/H-79/01

Utah Water Research Laboratory
Utah State University
Logan, Utah

January 1979

ABSTRACT

The response of infiltration rate (f_c) to grazing systems is modeled, based on infiltration-grazing information available from past studies. As inputs the model uses a grazing system schedule, initial infiltration rate, and a characteristic recovery time. The output is a sequence of infiltration rates, from which hydrologic impact inferences may be made. Background, development, usage, cautions, and future research needs are given. A computer program of the model is supplied.

ACKNOWLEDGMENTS

This work was funded primarily by the U.S. Department of the Interior, Office of Water Research and Technology (Project JRN-035-1) through the Utah Center for Water Resources Research. The model arose from an earlier study done for the U.S. Department of the Interior, Bureau of Land Management, Colorado State Office, Denver, through the auspices of the USU Foundation, Logan, Utah. Support for auxiliary studies was received from the Utah Agricultural Experiment Station, Projects 749 and 696. A good deal of guidance review and advice was also generously given by personnel of the U.S. Department of Agriculture, Forest Service; and Science and Education Administration (SEA), Southwest Watershed Research Center, Tucson, Arizona.

Gifford (cont'd)

Additional handouts from presentation include:

Rainfall Simulation under Wildland Conditions. Where do we Stand? - G. F. Gifford

(Third Conference on Hydrometerology,
August 20-24, 1979, Bogota, Columbia)

Deterministic Hydrologic Modeling of Grazing System Impacts on Infiltration Rates

G. F. Gifford and R. H. Hawkins - Water Resources Bulletin, AWRA, Vol. 15 N. 4, August 1979

Infiltration Dynamics Under Various Rangeland Treatments on Uniform Sandy Loam Soils in Southeastern Utah.

G. F. Gifford, Journal of Hydrology, 42 (1979) 179-185.

Climate Capabilities for Predicting Vegetative Growth and other Watershed Parameters -

Arlo Richardson - Utah State Dept. of Agriculture,
Climatologist - Utah State Univ. (edited from notes)

The object of the research is to predict production and phenology and to carry the modeling into a usable range management technique.

The model evaluates seven phenological factors for the purpose of estimating growth response to temperature and precipitation. The growth model will be converted to specie response, composition response, form, size and aerial distribution information. The modeling is trying to account for fall regrowth also.

Use in range management would include range readiness by evaluating phenological stages of key forage species and seeding success where probability of precipitation is known.

More information can be obtained through Dr. Richardson at Utah State University - 801-751-1000

Interagency Management Objectives for the Saval Ranch Hydrologic Studies

John Brown, Hydrology Professor - University of Nevada, Reno

John Loomis, Hydrologist, BLM (edited from notes)

The Saval Ranch project is in the initial start-up stage for the purpose of developing conceptual relationships of cattle use, site characteristics, plants, rest, etc. The project intends to develop quantitative systems for the measurement of soil loss, runoff and effects of livestock grazing.

For more information contact Eric Janes, DSC, 234-2374.

Review of 7441 Fire Rehabilitation Manual - Ed Fisk, Range Conservationist, W.O., BLM -(edited from notes)

The final manual should be released in early January. It is in the surname process at present.

- The EAR on the proposed rehab should be complete. This includes mitigation, land status description, annual precipitation, etc. Leave out unspecific material.
- Each district should be doing more pre-planning each year.
- There should be one plan per fire unless the areas are very similar.
- There should be very specific information on what is to be done for archeological, T&E clearance.
- Should be clear on what is to be charged to the fire and to the emergency fire rehabilitation. Fences destroyed should be charged to the fire.
- Precipitation information should support seed mixture proposed in EFR plan.
- Plan should cover management system used to protect rehabilitation.
- Water developments can be used for establishing rehabilitation.
- Plan should cover evaluation, test plots, period of evaluation (3 years).

William T. Mabbutt - Natural Resource Specialist - Idaho State Office

Practical Aspects of Fire Rehabilitation

Mr. Ed Fisk has passed out a draft 7441 Emergency Rehabilitation manual. This manual should be reviewed as soon as possible with comments being sent to Ed Fisk.

Ed mentioned the use of certified seed for rehabilitation projects. I feel that we don't need certified seed for rehabilitation projects for the following reason.

1. The amount of seed needed would not be available on the market.
2. The cost would increase.
3. We should keep the purity and germination at a high standard when the bids for purchase are being prepared.
4. The seed growers would have to be geared to furnish certified seed for a large volume on short notice for different states.

It is my understanding that next year we will be doing economic analysis on fires over $50,000.

Each state with fire rehabilitation program should be geared to do the analysis. In Idaho we are doing one economic analysis on a fire with an estimated cost of $85,500. This should give us experience in working as a team with the help of an economist.

The Washington Office should review the $50,000 guideline for economic analysis. We should consider the inflation and what $50,000 will accomplish under our present economic conditions. Suggest the requirement be raised to fire rehabilitation projects costing over $75,000.

Prescribed Burning — Effective Control of Sagebrush and Open Juniper

Michael Ralphs, David Schen, and Fee Busby

Millions of acres of western rangeland are dominated by stands of sagebrush and juniper. These brushlands are generally considered to be of low value for livestock forage, watershed protection, and wildlife habitat. Mechanical and chemical methods have been successfully used to manage these unproductive plants, but inflation has increased their cost and made them uneconomical in many situations.

Prescribed burning — the carefully planned use of fire — is an efficient and economical range management tool, however, and can be used to manage sagebrush and juniper. Fire is dangerous and can be destructive, but careful planning, application, and follow-up management can reduce the risk associated with prescribed burning.

Prescribed burning or any range improvement practice should be identified as necessary in a comprehensive, long-term ranch management plan. Assistance in developing a good plan can be obtained from the Soil Conservation Service, Bureau of Land Management, Forest Service, Utah Division of Wildlife Resources, Utah State Department of Forestry, and USU Extension Service. This paper discusses some of the precautions a manager must consider before selecting prescribed burning as a desirable range improvement practice.

Effect of Fire on Vegetation

All plants are affected by fire, but the extent of damage or benefit varies with the plant species and the intensity of the fire. The manager must know the plants he is working with and how they are affected by fire. The burning conditions and timing of the prescribed burn should be planned to benefit the desired plants in the community as well as damaging the target species.

The growing points of most grasses and some forbs are at the ground surface in the root crown. A fast moving, low intensity fire will consume the aerial vegetation without damaging the crown (note in Table 1 that some grasses such as Idaho fescue are severely damaged). However, the growing points of shrubs are at the tip of the branches and those without the ability to resprout from the root are killed by fire. Sagebrush and juniper do not resprout and are easily managed by prescribed burning. Rabbitbrush and other problem plants do resprout and cannot be managed this way.

Prescribed burning is an efficient and economical range management tool for sagebrush and juniper

Advantages of Prescribed Burning

1) Inexpensive control method. The major cash cost is for fuel breaks and ignition fuel and is usually less than $.50/acre.

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2) Releases soil moisture and nutrients for desirable vegetation.
3) Increases forage production for livestock and wildlife.
4) Increases palatability of vegetation on burned areas.
5) Temporarily increases winter yield.
6) Sagegrouse strutting grounds and key wildlife areas can be excluded from burn by fuel breaks.
7) Increases diversity of vegetation and improves wildlife habitat.

Disadvantages of Prescribed Burning

1) Risk of fire escaping and consuming valuable forage, causing property damage and danger to lives, resulting in expensive suppression costs and civil suits.
2) Soil erosion by wind and water until vegetative cover is re-established.
3) Increases the amount of cheatgrass if it is abundant in understory.
4) Rabbitbrush and other problem species that resprout from the root will increase after a fire and present additional management problems (Table 1).

The advantages and disadvantages should be evaluated for each project and where the disadvantages outweigh the advantages, alternative means of brush management should be chosen.

Late Summer and Fall Burning

Destructive wildfires often occur during July, August, and September when temperatures are high, humidity is low, and plant foliage is dry and flammable. However, if precautions are taken, these high risk fire conditions can be used advantageously in prescribed burns. Adequate fuel breaks must be constructed and fire suppression equipment must be available to insure that the fire does not escape.

Broadcast burning of extensive areas — 200 hectares; (500 or more acres) — is best accomplished during late summer or fall. Large areas can be uniformly burned in a short time when the plants (fuel) are dry, relative humidity is less than 20 percent, daytime temperatures are above 24°C. (75°F), and steady winds from 16-24 km./hr. (10-15 mi./hr.) and from the desired direction occur.

Spring Burning

Early spring burning offers advantages for some special situations. Timing is critical because the prescribed burn must be conducted just after the snow melts and before sagebrush and juniper break dormancy. This often constitutes less than a two-week-period. During this

Table 1. Foothill plants affected by fire.

	Severely Damaged	Moderately Damaged	Slightly Damaged
Desirable[1]	Bitterbrush Cliffrose Curlleaf mountainmahogany Eriogonum Idaho fescue Threadleaf sedge	Bluebunch wheatgrass Indian paintbrush Indian ricegrass Needle-and-thread Nevada bluegrass Penstemon Prairie Junegrass Squirreltail Thurber needlegrass	Arrowleaf balsamroot Crested wheatgrass Douglas sedge Sandberg bluegrass Serviceberry Snowberry True mountainmahogany Western wheatgrass Yarrow
Undesirable[1]	Sagebrush Juniper Pinyon pine Pussytoes	Tailcup lupine	Broom snakeweed Cheatgrass Deathcamas Horsebrush Rabbitbrush Velvet lupine

[1] Desirable and undesirable classification is based on usability for livestock forage.

period, the foliage water content is low in relation to the volatile oils and the plants burn readily.

The temperatures during this season are low and the humidity is high. This results in a cool fire and only the dense concentrated sagebrush in the bottom of a draw will burn. Although the major targets of spring burns are small areas, the method can be a valuable tool in clearing out these potentially productive bottoms when fire suppression cost is minimal.

Planning

After the range manager has made the decision to use prescribed burning as a brush management tool, the Area Forester and District Fire Warden of the State Division of Forestry and Fire Control should be contacted for assistance in planning the individual burning project. These individuals can assist in recommending the season to burn, the size and number of burning units, the location and width of fuel breaks, desirable weather conditions, and the kind and amount of suppression equipment that will be needed during the fire. The Fire Warden will issue the burning permit when he is satisfied that proper precautions are included in the burning plan.

Fuel

Fuel type and density are probably the most important factors to consider in planning the number and size of burning units, the placement and width of fuel breaks, and the amount of suppression equipment needed. A fire will carry easily with only a light breeze in dense brush with moderate to heavy fine fuels (grass). Therefore, the area to be burned should be rested from grazing the season before the burn is planned. This allows a buildup of the needed fine fuels which is necessary for a safe and easily controlled fire. In sparse or moderately dense brush with little fine fuel, a strong wind is necessary to carry a fire. The stronger or more gusty the wind, the greater the problems of fire control.

Topography

The general topography of the area surrounding the proposed burn as well as the topography of the site to be burned must be considered in determining the location and width of fuel breaks. The rate of fire spread will be much faster up a hill because of convection and radiant heat transfer which causes preheating of fuels ahead of the fire. Therefore, fuel breaks must be much wider if the fire is moving upslope.

Burning Units

Large prescribed burns — greater than 80 hectares (200 acres) — are often more safely conducted by dividing them into several small burns. The larger the area ignited at any one time, the greater the risk of problems occurring in fire control. The first units to be burned should be those on the downwind side of the area. Once these have been burned, since the wind will carry the fire in their direction, larger units may be safely burned.

Ignition of too large a tract and spreading control crews too thin around a large area are unnecessary safety risks.

Fuel Breaks

Although specific site conditions will dictate fuel break width and location, one can generally conclude that in moderate to dense juniper a break of 30.4 m. (100 feet) is required, while in sagebrush widths of 15.2 m. (50 feet) are generally adequate. These widths will have to be increased if the planned fire direction is upslope or sparse fuel necessitates burning in strong winds.

The entire fuel break may be constructed with dozers, although this may prove more costly than necessary and certainly causes some undesirable scarring of the area. Another way is to cut a narrow break with the dozer and then burn strips parallel to the dozed break. These strips can be burned when fire conditions are conducive to safer burning (during the late afternoon). Several strips may need to be burned to obtain the desired total width.

A new device being developed by the Forest Service may eliminate the need for dozing any fuel breaks. It consists of a propane burning unit mounted on a trailer with large blower fans. The unit can light a fire in wet or moist conditions, the blowers fanning the fire until the plants ignited by the burners are killed. Several of these strips may be burned to achieve the desired total width. In wet or moist conditions, however, (in spring, after plants have broken dormancy) the fire will not spread.

If possible, existing roads should be used for fuel breaks; new breaks may serve as roads.

Application

On the day of the burn, the Fire Warden, Area Forester, or whoever is designated as the Fire Boss should direct all activities. Strong leadership is very important in conducting a safe and organized burn.

Fire Weather

Weather factors such as relative humidity, wind velocity, wind direction, and temperature have a direct influence upon the likelihood of conducting a safe and efficient burn. The prevailing midday wind direction should have been determined in the planning process and considered in setting up the burn-

ing units. The humidity, temperature, and wind velocity and direction for the day of the burn is essential information and can be obtained from an on-site mobile weather station provided by the US Weather Service. For best results, the day of the burn should have a predicted humidity less than 20 percent, temperature above 24°C (75°F), and a steady wind 13 to 24 km./hr. (8 to 15 mi./hr.).

Ignition

The burning units on the downwind should be ignited first. They can be backfired if there is little wind and adequate fuel to carry the fire. Ignition can be done with either backpack or mobile burners. It is important to ignite the entire width of the unit as rapidly as possible to create a line of fire that the wind can carry uniformly over the unit. If the burn is patchy, it may be necessary to treat individually the unburned islands.

Suppression

In the planning process, it is necessary to arrange for fire suppression equipment and fire crews to be on the site both in burning out the fire guards and for the actual broadcast burn. The amount of suppression equipment and size of crews will be determined by the Fire Warden or Fire Boss based on the size of the burn, topography, and burning condition. Equipment and manpower must be strategically located to immediately suppress any fire that escapes the fuel breaks.

Follow-Up Management

Follow-up management is the most important aspect of a controlled burn and must be provided for in the overall management plan. On areas lacking sufficient desirable grasses in the understory (less than 20 percent of vegetative cover), reseeding may be necessary to insure a rapid recovery of the site. Resting the unit for two growing seasons provides for the establishment of seeded grasses and the increased vigor and density of the native grasses. Proper grazing thereafter with periodic rest will extend the increased forage production for many years.

Sagebrush and juniper and other undesirable shrubs are natural components of the ecosystem and will become re-established on the burned area. If these again become dominant, it may be necessary to retreat the site in order to maintain a productive condition.

An Example — The Park Valley Demonstration Ranch*

One pasture in the Park Valley Hereford Corporation Ranch, north of Park Valley, Utah, was successfully burned during September, 1974. The general procedures followed are discussed to illustrate how proper planning makes prescribed burning a useful management tool.

Figure 1 illustrates the existing characteristics of the project area. The area selected to burn was flat to gently sloping. Similar topography occurred on adjacent lands on the east, west, and south. Steep mountain slopes with sparse vegetation are adjacent to the area on the north.

Soils were generally shallow and rocky. However, a good grass stand resulted from reseeding a wildfire that occurred in 1970. This seeding served as an indication of what could be expected from prescribed burning and seeding on these soils.

Roads existed prior to the burn and were utilized as fuel breaks and unit dividers. Additional breaks were constructed with a D-8 Caterpiller dozer. These breaks were 10-15 feet wide. The width was increased to approximately 50 to 100 feet by burning strips on the downwind side of the units.

The juniper stand was dense and the sagebrush stand was sparse to dense. The area had been grazed prior to the burn and very little fine fuel was available to help carry the fire. Vegetation in the draws was very dense.

Units 1, 2, and 4 in Figure 2 were burned first to provide additional breaks near the steep mountain slopes. This allowed the larger Units 3, 5, and 6 to be more safely burned. A US Weather Bureau mobile unit was used to monitor fire weather conditions prior to the burn.

The juniper burned poorly in the morning but burned well in the afternoon (noon to 4:00 pm) after temperatures increased, relative humidity decreased, and a steady, moderate 16 to 24 km./hr. (10 to 15 mi./hr.) wind prevailed. Juniper burned well only where conditions allowed crown fires to develop.

The sagebrush burned well from 10:00 am to 4:00 pm except for sparsely vegetated areas. Winds from 8 to 16 km./hr. (5 to 10 mi./hr.) were required to carry the fire through most areas of sagebrush.

The dense vegetation in the draws burned readily throughout the day. These possibly could have been burned in the spring and then utilized as fuel breaks during the fall prescribed burn.

It became more difficult to burn during the late afternoon. As temperatures decrease, relative humidity increases and plants burn much slower. Therefore, late afternoon would be a safe time to burn fuel breaks or dense stands of easily burned vegetation.

Control efforts were minimal with suppression required once in

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*Demonstration Ranch Program is conducted with the assistance of the Four Corners Regional Commission.

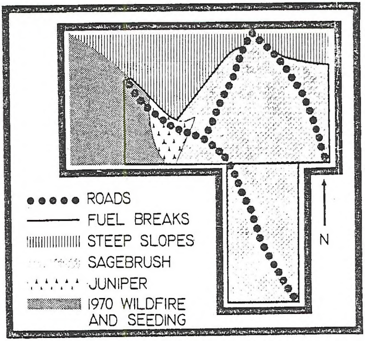
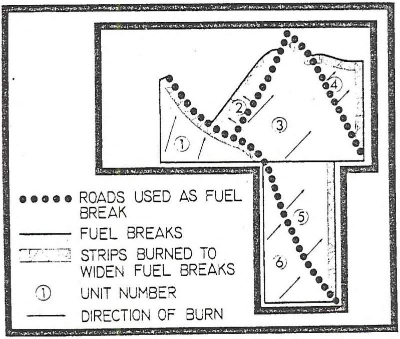


Figure 1. Characteristics of Park Valley prescribed burn area.



①
②
③
④
⑤
⑥
●●●●● ROADS USED AS FUEL BREAK
FUEL BREAKS
STRIPS BURNED TO WIDEN FUEL BREAKS
① UNIT NUMBER
DIRECTION OF BURN

Figure 2. Sequence of burning units.

Unit 2 and twice in Unit 3. In both cases steep slopes adjoined the area resulting in fuel preheating and ignition by convection or fire brands. The problem could have been lessened by wider or relocated fuel breaks. Whirlwinds were a continual threat but caused no problems.

Control equipment on hand included two 1,000 gallon tankers, four 250 gallon 4 X 4 pumper units, and a SCD D-8 Cat. There were 20 men on the scene, adequate for the job.

The prescribed burn was a total success. The actual cash cost of the burn was $.99 per hectare ($.40 per acre). This included fire line construction and fuel for the ignition torches. If the volunteer labor and equipment was included, the total cost of the burn would have been $7.81 per hectare ($3.16 per acre). The costs are considerably less than $17.30 per hectare ($7.00 per acre) for spraying sagebrush and $44.48 per hectare ($18.00 per acre) for chaining juniper. The area was drilled to crested wheatgrass in November and is growing successfully.

Summary

In considering prescribed burning as a range improvement tool, three major considerations stand out. 1) The prescribed burn should be one of several alternatives of improvements considered in an overall ranch improvement and management plan. 2) Careful planning for the prescribed burn is required in order to obtain the desired results and minimize the risks associated with fire. 3) Follow-up management is essential in establishing a productive forage cover and extending its useful lifetime.

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Endangered and Threatened Plant Program
Great Basin Watershed Workshop Nov. 5-8, 1979

Endangered Species Act:

The Endangered Species Act became effective December 28, 1973 (P.L. 93-205 as amended) Manual 6840, Appendix 1.

Purpose: . . . to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species.

Policy: . . . It is further declared to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the Act.

The Act obligates all agencies to implement the purposes of the Act and to insure that actions authorized do not jeopardize the continued existence of endangered or threatened species or result in the destruction or modification of their critical habitats.

Thus, e.g., grazing licenses and permits both (renewals and new), and timber sales must comply with the ESA.

BLM Policy: (W.O. 79-64)

It is Bureau policy to protect, conserve, and manage Federally- and State-listed or proposed listings of sensitive, endangered or threatened plants and to use its authorities in furtherance of the purposes of the Endangered Species Act and similar state laws. The Bureau, through its actions and/or decisions in all planning and management activities, will ensure that actions authorized, funded, or carried out will not jeopardize the continued existence of such species or result in the destruction or modification of their critical habitats.

Pending final listing, or delisting, all Federal- or State-proposed (candidates) sensitive, endangered or threatened plant species must be afforded the full protection of the Endangered Species Act, unless it is determined by the State Director on a case-by-case basis that information on the occurrence of a plant species is adequate to allow a specific action.

The objectives of all programs will include the means to conserve officially-listed plants, to promote delisting, and/or to enhance or maintain the ecosystems occupied by plants on Federal or official state inventories. It is also policy to ensure that the habitats of sensitive plants will be managed and/or conserved to minimize or eliminate the need for Federal or State listing in the future. Also, see P.L. 94-579 Sec. 102(a)(8).

3. Taxonomic status of the species (e.g., taxa with no taxonomic problems will have a higher priority; species will have higher priority than variety or subspecies).

4. Recovery potential - species which have high potential for recovery will be given first priority.

PLANT LISTS:

The two lists that have Federal status at this time are the July 1, 1975 Federal Register list of recommended candidate threatened plant species and the June 16, 1976 Federal Register list of proposed endangered plant species.

In Oregon, information from all sources, i.e., Federal Register, Oregon Provisional List, was consolidated in accordance with W.O. Instruction Memorandum No. 76-609, November 15, 1976 (now expired). This Bureau composite list "Suspected Sensitive, Endangered or Threatened Plant List of Oregon and Washington" has been updated annually.

There are no official State lists of plants in Idaho, Utah, Oregon or Washington. In Oregon a provisional list has been collated by an informally organized volunteer group, Oregon Rare and Endangered Plant Species Task Force.

In our four-state area at the present time, there are two Federally-listed E/T plant species in Utah. The July 1, 1975 and June 16, 1976 Federal Register lists meet the criteria of Bureau policy as "sensitive species" and must be afforded the full protection of the Endangered Species Act.

The State of Nevada has listed 18 critically endangered plant species under the authority granted in NRS 527.270.

	Federal Proposed & Candidate E/T Flora			
	E	T	Official List	State Law
Idaho	23	38	--	--
Nevada	49	82	--	NRS 527.270
Oregon	51	135	--	Partial
Utah	55	132	1E, 1T	--
Wash	18	67	--	--

DEFINITIONS

Candidate species: See sensitive species.

Endangered species: Any species of plants or animals which are in danger of extinction throughout all or a significant portion of its range.

B. Each field office must, as a continuing effort, determine: (1) which candidates or listed plant species, are known or suspected to occur within their area of responsibility, and (2) which are known or suspected to occur on Bureau administered lands, or can reasonably be expected to be influenced by Bureau actions.

Public Law 94-579, Federal Land Policy and Management Act of 1976 (FLPMA) Section 102(a)(2) provides -

> (2) the national interest will be best realized if the public lands and their resources are periodically and systematically inventoried and their present and future use is projected through a land use planning process coordinated with other Federal and state planning efforts.

Thus, conducting inventories as to the occurrence and distribution of E/T plant species is another first priority task of the Bureau. Botanical inventory information provides the basis for analyzing the effects of planned actions. When the occurrence of an endangered or threatened species is confirmed, the obligation to protect it and its habitat is mandatory.

C. Management alternatives and decisions must be based upon species distribution, occurrence, populations, habitat, nature of threat, environmental requirements, population trends and prerogatives of the managers.

The E/T flora decision process or management strategy follows the following sequence:

1. Inventories - field examination
2. Management recommendations
3. Decisions

Thus, current and accurate inventory data is essential for analyzing the effect of planned actions and to substantiate MFP recommendations.

D. Allocation of Resources:

Priority in allocating vegetation -

1st - For maintaining or increasing key species of plants to enhance soil productivity, reduce erosion and runoff, protect water quality, and ensure sustained and improved vegetation production.

2nd - For protecting any plant species or its habitat listed as threatened or endangered.

3rd - For providing forage for livestock, wild horses and burros, habitat for fish and wildlife, and for enhancing scenic and other values. (Also see W.O. Info. 79-240)

C. Review or search herbaria records. Herbaria search information is often available through state National Heritage programs or the Fish and Wildlife Service.

D. Stratify field (search) inventory to suspect areas by determining potential habitat and probability of occurrence. This will identify areas for scheduling priority field work. Site specific data, along with autecology and plant phenology information is essential in the identification of suspect areas for establishing inventory schedules.

Caution. Positive field identification of many plant species is possible only during certain seasons. Consequently, time delays may result in the planning and review process if field inventories for E or T plant species are required. To minimize such potential delays, the E/T flora situation should be determined at the earliest practical stage of the planning process (normally during development of the pre-planning analysis).

Phase II: Field Examinations (Biological Assessment)

A. Conduct field inventory and species verifications.

1. Determine population parameters.
2. Document observations (Plant Taxon Report)

Phase III: Office.

A. URA/MFP Data

1. Complete and file field reports. (Species record files)
2. Prepare status report.
3. Input URA.

B. Reports (Reserved)

S, E, or T SPECIES MANAGEMENT:

A. Develop MFP, Step 1 recommendations.

B. Project-related data

1. Review proposed action. When a proposal poses a threat to an E or T species, the following actions must be considered:

   a. Abandon proposal or plan.
   b. Modify proposal to avoid impacting species--alternatives.
   c. Postpone

When a project proposal can be modified so that S, E or T plants will not be jeopardized, these modifications must be documented. Identified safeguards will be clearly set out in the environmental record report and project plans, i.e., JDR's, timber sale, and field personnel will be fully responsible for implementing them.

2. When the review does not reveal any effects on listed species or their habitats, no further action is required unless requested.

Following is a recommended biological assessment information format that may be used when requesting Section 7 consultation on plants.

a. Brief description of site where species occurs (legal description).
b. Size of area (acres) of habitat to be impacted by action.
c. Management alternatives considered for protection of species.

Often it is possible to modify a proposed action so that populations of sensitive, endangered or threatened species can be avoided. When a proposed plan of action can be modified, consultation with the Fish & Wildlife Service will not be required as provided by W.O. Instruction Memorandum 78-72, Enclosure 2-1, Item 2b.

d. Consideration of cumulative effects on species or habitat.
e. Difficulties encountered in obtaining data, etc.
f. Monitoring plan, if needed.
g. Copy of species status report.

    1. All status reports and field reports should be identified to author.

    2. All referenced sites for E/T plants should indicate whether or not the population is vouchered. If unvouchered, (i.e., no specimen collected), then identity of the person making the verification and his qualifications need to be included. If vouchered, collector's number and herbarium where deposited should be included.

h. Other, e.g., identify funding activity--cost of activities associated with FWS, Sec. 7 consultations must be charged to the program initiating the action. This also includes any additional studies or data needs identified for compliance.

E. Recovery plans -

Recovery plans are guides containing essential actions that will secure or restore an E or T species as a viable, self-sustaining member of its ecosystem.

F. Population Monitoring (effects of activities and disturbances)

USE OF THE SOIL-VEGETATION INVENTORY METHOD - Dennis Froeming

SCS/BLM(ISO) - Boise, Idaho

The soil-vegetation inventory method (SVIM) gathers data and information which can be useful to watershed people. It is desirable that you spend some time with the SVIM crews and learn what kind of data they are collecting and how the job is being done.

There are three documents available from the soils and vegetative people which can be useful to watershed people.

1. SCS - Soils - 5 - has information about a particular soil series including:

    a) brief soil description
    b) Unified and AASHO classification
    c) particle sizes
    d) bulk density
    e) permeability and available water capacity
    f) shrink-swell potential
    g) K & T factors
    h) flooding and water table info
    i) subsidence
    j) hydrologic group
    k) cemented pan and bedrock

2. V-1 Form - A 200-point step point transect which will provide ground cover data and cover by different canopies.

3. V-2 Form - Weight estimate and vegetation characterization form. This form provides information on plant characteristics including availability, phenology, utilization, and weights of vegetation by height categories. Also on selected plots data on height, crown size, and age and form class are collected.

Another source of information which should be used is the range or ecosite descriptions which are being developed by BLM and SCS. They describe what the potential plant community for a given site should look like.

When managing rangelands we are essentially managing vegetation on plant communities. We need to know the potential of the land and what type of vegetation, ground cover, and responses to management for which the site is capable. Look at the vegetation. Often it will tell us we have a problem before other indicators, such as erosion, become evident.

Riparian areas offer a big management challenge. We need to be innovative and imaginative and develop management practices and schemes which are practical and economically feasible and effective in managing grazing in the riparian areas.

RANGELAND IMPROVEMENT PRACTICES AND GUIDELINES FOR ECOLOGICAL UNITS

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In the past several years we have seen a wide diversity of proposed rangeland improvement actions which have been analyzed in grazing environmental impact statements. These have ranged from no treatments proposed to large acreages proposed for treatment. In many cases, these proposals have not been related to current range condition, potential or specific management goals so much as they have to a manager's intuition about the availability of funds to accomplish range improvements. In other words, some have reasoned that funding will not be available and they do not plan improvements while others have disregarded funding and planned as much improvement as physically feasible.

This diversity of action has caused considerable concern within BLM and among user groups. Because of this it appears that we need to do two things. First, we must establish common goals and time frames to measure against. Second, we must establish a common procedure for assessing rangelands to determine what actions are necessary to meet these goals.

The basis for the establishment of a common goal is given in a paragraph of BLM Manual 1603.12G, Range Program Activity Policy Statement, which reads:

Paper presented at BLM's 1979 Great Basin Watershed Workshop, Elko, Nevada, November 5-8, 1979.

> A reasonable time frame for accomplishment of AMP objectives will be used (for example, 20 years). The need for artificial rehabilitation will be weighed against the opportunities to accomplish resource objectives through livestock manipulation or other management alternatives.

In Utah we have expanded this policy to analyze each site writeup area (as defined in BLM's Soil-Vegetation Inventory Method Manual) against standard criteria. Basically the policy provides that where grazing management will not attain 75% of the desired vegetation goals for a given site writeup area in 20 years we should plan the least cost treatment which will meet the goals for that site writeup area. The consolidation of these individual decisions sets the framework for action on the entire allotment. This assessment is made in the allotment analysis phase, before unit resource analysis (URA). The criteria does not consider the question of available funding, but considers only the attainment of specific vegetation goals in a given time frame. (see enclosure 1 for this criteria). Available funding, as well as conflicts with other resource values, may well change the final improvement actions taken, but we should initially assess areas with a common yardstick.

Once we have established and accepted criteria the real challenge to rangeland managers is to determine whether management will or will not meet the goals set for vegetation composition and production in the time frame established. There are simply too many variables involved in

such determinations to set hard and fast formulas to follow. However, a systematic assessment can be made using SVIM Data. Probably the most useful data available for determining the need for treatment and what type of treatment is most appropriate is plant density (number of plants per acre) and spacing by species. This data is needed for the present plant community on the site writeup area and the potential plant community for that particular soil series or phase of soil series. Density is one of the SVIM data outputs. (see enclosure 3 for an example of this data output) This data can be roughly translated to spacing by using the Table entitled Spacing of Plants of Various Densities (Number of Plants Per Acre). This is included here as enclosure 2. Density is not a part of the current Range Site Descriptions and will not be available for the potential plant community unless comparison area studies for a particular soil series or phase of soil series have been conducted using the Soil-Vegetation Inventory Method. Two elements need to be emphasized here: First, comparison area data for each soil occurring in an inventory area are essential for adequate analysis. Second, Range Site Descriptions need to be revised to include this essential analysis data. We are beginning to make these revisions in Range Site Descriptions in Utah.

To aid in the assessment we should have an additional output from the automated SVIM data. This data output would be entitled Rangeland Improvement Planning Data. It would show the number of plants per acre, average spacing and pounds of production per acre by species for a given

soil series or phase of series within an allotment. This data would be shown for each comparison area and each site writeup area where this soil series occurs within the allotment. Again, this data will not tell a rangeland manager to treat or not to treat or the appropriate treatment, but it will place the pertinent information before him so that a rational decision can be made.

This data output would look something like that shown in enclosure 4. A hypothetical example of the data display is also shown in this enclosure. Within the Buckskin Mtn. Allotment soil number 4009 occurs on four site writeup areas. One is a comparison area. It shows the data discussed above for the comparison area and the three other site writeup areas where this particular soil series occurs. We know the properties of this soil series from the soil description and what treatments are physically feasible.

This is a big sagebrush-grass site. Site writeup area (SWA) B140 is currently in a high seral stage and compares favorably to the comparison area. We would probably interpret from this data that grazing management will accomplish our goals for that SWA.

Site writeup area D095 is in a medium seral stage. Sagebrush density has increased considerably over that shown for the comparison area. We may plan to treat this SWA in a manner that would least disturb the desirable plants in this community, either herbicide application or

prescribed burning.

Site writeup area D096 is in a low seral stage. Sagebrush density has greatly increased over that shown for the comparison area. Densities of desirable plants in the community are far below those in the comparison area. We would need to plan a treatment which would eliminate the sagebrush competition and seed this site writeup area.

Many of the actual situations we will face will not be this clear-cut. In those situations we do not want to forget the time honored procedure of pilot projects. We might be guided by a little jingle..."If you ponder it, pilot it".

In the improvement assessments I have discussed today I do not mean to imply that we are starting without precedent. Much valuable work has been done. We should certainly be aware of the literature applicable to the particular situation we are assessing.

I do believe that we have barely scathed the surface on treatment techniques. In view of increased costs of fuels and materials we must look for new and more efficient methods.

8/14/79

RANGE MANAGEMENT PLANNING POLICY

The policy outlined below addresses decision processes applied to individual site writeup areas within an allotment.

The consolidation of these individual decision processes sets the framework for action on the entire allotment.

RANGE MANAGEMENT PLANNING POLICY

Planning Stage	Assumptions and Process	Time-Frame
Allotment Analysis	Assumptions - the following assumptions are applied in analyzing the potential of each site writeup area in the analysis stage.	
	1) Management. Do not specify what management system is to be applied but assume the best form of management is applied now to the site writeup area. What is the maximum production attainable for this site writeup area in 20 years.	20 years (Note: Maximum production without regard for the time necessary to reach that production will be known from SVIM data compilation.)
	2) Treatment. Assume that each technically feasible treatment is applied now to each site writeup area. What is the potential of the writeup area for each treatment in 20 years (in acres/AM). Assume necessary maintenance and the best form of grazing management is applied.	20 Years
	Process - Compile grazing capacity (for livestock grazing only) on the basis of the above assumptions and in accordance with Allotment Analysis instructions.	
Unit Resource Analysis	Process - Compile treatment opportunities by allotment.	
MFP Step 1 (Activity Recommendation)	Process Alternative 1. Situation - Management will attain 75% of the potential of the site writeup area. Action - Resource activity recommendation for the writeup area will be to apply management (i.e. no treatment is recommended).	Determine what production will be in 20 years. Also, determine what additional production is expected (beyond 20 years) without regard to time required.

Enclosure 1

Planning Stage	Assumptions and Process	Time-Frame
	Alternative 2. Situation - Management will not attain 75% of the potential of the site writeup area. Action - The Resource activity recommendation for the site write-up area will be to apply the least cost treatment alternative which will attain the desired vegetation production.	Initial assessment is made on the basis of a 20 year time-frame. Actual time of availability of forage will normally be less than this where treatments are applied.
	Alternative 3. Situation - No treatment is technically feasible for the site writeup area. Action - The Resource activity recommendation for the writeup area will be to apply the best form of grazing management.	Determine what production will be in 20 years. Also, determine what additional production is expected without regard to time required.
MFP Step 2 (Multiple Use Analysis)	Process Alternative 1. Situation - Treatment proposed in Step 1 does not conflict with other activity recommendations. Action - Carry Step 1 recommendation forward to Step 3 of the MFP.	Variable depending on treatment and rest from grazing required. Generally less than 20 years.
	Alternative 2. Situation - Treatment proposed in Step 1 does conflict with other activity recommendations. Action - Assess other technically feasible treatments in the order of expected yield (i.e. those which will yield the highest production - or require the least acreage per animal month). In some cases resource conflicts will be such that no technically feasible treatment will be acceptable for a given site writeup area. In many cases alternative treatments will be acceptable.	If treatment is applied the time-frame would be as in alternative 1. If resource conflicts are such that no treatment is acceptable, determine what production will be in 20 years. Also, determine what additional production is expected (beyond 20 years) without regard to time required.
Allotment Planning 1. Management Section	Process At this point in the planning process decisions on individual site writeup areas fall into three categories as follows: A. Seventy five percent or more of site potential would be attained through management alone. Notreatment would have been proposed B. Seventy five percent or more of site potential would not be attained through management.	

Planning Stage	Assumptions and Process	Time-Frame
	1. Treatment was proposed in Step 1 of the MFP. Because of conflicts in the Management Framework Plan the treatment proposal (or an alternative treatment proposal) was not carried forward to this planning stage.	> 20 years (to reach potential).
	2. Treatment was proposed in Step 1 of the MFP. No conflicts were identified in the Management Framework Plan. The treatment proposal was carried forward to this planning stage.	< 20 years (to reach potential)
	C. Seventy five percent or more of site potential would not be attained through management. No treatment is feasible.	> 20 years (to reach potential)
2. Benefit/Cost Analysis Section	Process - On the basis of the above proposal a benefit/cost analysis is conducted. This analysis is conducted on the basis of actual time of benefit derived from increased forage production. If benefit/cost ratio of one to one is obtained in this analysis the proposal should be included in the Allotment Management Plan. If a benefit/cost ratio of less than one to one the proposal should be re-analyzed to determine other alternatives that would reduce costs, but that would achieve AMP objectives.	Variable - based on actual time increased vegetation production is available for use.

SPACING OF PLANTS AT VARIOUS DENSITIES

Plants/Acre	Spacing (ft)	Plants/Acre	Spacing (ft)	Plants/Acre	Spacing (ft)
43,560	1 x 1	279	12.5 x 12.5	76	24 x 24
19,360	1.5 x 1.5	258	13 x 13	73	24.5 x 24.5
10,890	2 x 2	239	13.5 x 13.5	70	25 x 25
6,970	2.5 x 2.5	222	14 x 14	67	25.5 x 25.5
4,840	3 x 3	207	14.5 x 14.5	64	26 x 26
3,556	3.5 x 3.5	194	15 x 15	62	26.5 x 26.5
2,722	4 x 4	181	15.5 x 15.5	60	27 x 27
2,151	4.5 x 4.5	170	16 x 16	58	27.5 x 27.5
1,742	5 x 5	160	16.5 x 16.5	56	28 x 28
1,440	5.5 x 5.5	151	17 x 17	54	28.5 x 28.5
1,210	6 x 6	142	17.5 x 17.5	52	29 x 29
1,031	6.5 x 6.5	134	18 x 18	50	29.5 x 29.5
889	7 x 7	127	18.5 x 18.5	48	30 x 30
774	7.5 x 7.5	121	19 x 19		
681	8 x 8	115	19.5 x 19.5		
603	8.5 x 8.5	109	20 x 20		
538	9 x 9	104	20.5 x 20.5		
482	9.5 x 9.5	99	21 x 21		
436	10 x 10	94	21.5 x 21.5		
395	10.5 x 10.5	90	22 x 22		
360	11 x 11	86	22.5 x 22.5		
329	11.5 x 11.5	82	23 x 23		
302	12 x 12	79	23.5 x 23.5		

Enclosure 2

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REPORT DATE  09/28/79                    UNITED STATES DEPARTMENT OF THE INTERIOR                    PAGE NO     1
                          PCN: F050               BUREAU OF LAND MANAGEMENT
 STATE             UTAH                          SOIL VEGETATION INVENTORY METHOD
RESOURCE AREA     DIAMOND MTN              VEGETATION CHARACTERIZATION SUMMARY BY STRATUM
PLANNING UNIT     DUCHESNE
RANGE SITE        E47X181                               STRATUM 0001                       (INCLUDES  13 TRANSECTS)

 PLANT             NUMBER OF PLANTS/ACRE                           NUMBER OF PLANTS/ACRE                  AVE   AVE   WTD AVE    DENSITY
SYMBOL     ######### BY FORM CLASS ############        ############ BY AGE CLASS #################  HGT   CRWN  AVAIL %      PER
              1     2     3     4     5     6      S     P     Y      M     O     D     R         (FT) DIA.(FT)              ACRE

##GRASSES##
DOGR2        70     0     0     0     0     0      0     0     0     70     0     0     0    .1                100           70
ELSA      2,553     0     0     0     0     0      0     0     0  2,553     0     0     0   5.4                 98        2,553
ORHY        350     0     0     0     0     0      0     0     0    350     0     0     0    .5                100          350

##FORBS##
CHNA          0     0     2     0     0     0      0     0     0      0     0     2     0   1.3                100            2

##SHRUBS
  & TREES##
AMUT          0     0     1     0     0     0      0     0     0      1     0     0     0   3.2   4.8                         1
ARARN         1     0    13     0     0     0      0     0     0      1     0    13     0    .4    .5                        14
ARTR2        12     3     0     0     0     0      0     0     0     12     0     3     0    .6   1.0                        15
ATCO          5     0     0     0     0     0      0     0     0      5     0     0     0    .6   1.0                         5
CEMO2        31     0     6     0     0     0      2     0    16     16     0     2     0   1.6   1.7                        36
CHNA2         7     0     3     0     0     0      0     0     0      7     0     3     0   6.3    .9                        10
CHVI8         2     0     0     0     0     0      0     0     0      2     0     0     0    .4    .3                         2
EPTO          1     0     2     0     0     0      0     0     0      2     0     1     0   1.5   2.2                         3
EPVI          9     0     2     0     0     0      0     0     1      9     0     1     0   1.7    .9                        11
ERCO14       17     0     5     0     0     0      0     0     0     17     0     5     0    .9    .7                        22
EULA5         5     0     2     0     0     0      0     0     0      5     0     2     0    .4    .4                         7
GLME          6     0    10     0     0     0      0     0     2      8     0     7     0    .3    .8                        17
GUSA2        33     0     0     0     0     0      0     0     0     33     0     0     0    .4    .3                        33
JUOS         14     0     4     0     0     0      1     0     5      9     0     4     0   6.2   6.7                        19
LEPU         45    46     0     0     0     0      0     0     0     91     0     0     0    .2    .4                        91
OPPO          7     0     2     0     0     0      0     0     0      7     0     2     0    .2    .4                         9
PIED         57     0     5     0     2     0     14     0    24     20     0     4     0   6.7   5.5                        62
PSME          2     0     0     0     0     0      0     0     1      1     0     0     0  26.5  15.1                         2
SYORU         2     0     0     0     0     0      0     0     0      2     0     0     0   1.1   1.9                         2
YUHA         37     0     0     0     4     0      0     0     4     33     0     0     0    .3    .5                        37
end of  64
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Enclosure 3

RANGELAND IMPROVEMENT PLANNING DATA

ALLOTMENT Buckskin Mtn.

SOIL NUMBER 4009

Plant Symbol	Comparison Area 4 T / 0 6 / 3 7 S / 1 2 W / 6 0 1 Seral Stage climax			SWA # B140 % of SWA 100 Seral Stage high			SWA # D095 % of SWA 60 Seral Stage medium			SWA# D096 % of SWA 75 Seral Stage low			SWA# % of SWA Seral Stage		
	Plants/Acre	Spacing	lbs/acre	Plants/Acre	Spacing	lbs/acre	Plant/Acre	Spacing	lbs/acre	Plants/Acre	Spacing	lbs/acre	Plants/Acre	Spacing	lbs/acre
AGSP	4840	3x3	800	3556	3.5x3.5	600	2151	4.5x4.5	400	70	25x25	50			
FEID	3556	3.5x3.5	600	2151	4.5x4.5	400	1440	5.5x5.5	200	46	30x30	25			
ARTR	70	25x25	200	86	28.5x22.5	300	681	8x8	800	4840	3x3	2000			

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Enclosure 4

Nevada Land and Water Management Problems - Ed Evatz, Chief, Division of Resources, NSO-BLM (edited from notes).

- Water rights and grazing - Believes ranchers will move to help BLM when needs for range management outweight political pressure.
- Sagebrush Rebellion - Is providing an opportunity to educate the public on the importance of public lands and associated management problems.
- Staff - Internal expertise is good enough to handle almost any problem.
- Staff-Line Relationship - Need specialist to keep managers on time. Need better interchange between the staff and line.
- Workshops - Need management involved in workshops especially when developing new policy.
- Past Efforts - Keep and use old data; keep it useful and don't forget about it.

Effects of Grazing on Water Quality of Rangeland Streams[1]

G. R. Stephenson[2]

Prior to Federal Regulations, such as the National Environmental Policy Act of 1979, the 1972 Clean Water Act (Public Law 92-500), and the Federal Land Policy and Management Act of 1976, very little effort was given to evaluating water quality of rangeland streams. Most work of this nature was in forested regions and done for recreation purposes. Water quality investigations of rangeland streams at the Northwest Watershed Research Center were started in 1972 at the request of BLM in response to the above mentioned regulations. Evaluation sites have been established on the Reynolds Creek Watershed in Owyhee County and the Boise Front watersheds, northeast of the City of Boise. Management practices evaluated are deferred grazing, rest rotation, season long, and winter feeding. No ungrazed areas are available for comparison purposes.

The first step in the investigation was to evaluate past work in related studies. A review of the past work can briefly be summarized as follows:

1. Bacterial indicators in streams are directly related to cattle grazing.
2. Bacterial concentrations vary with runoff volume and season of year.
3. "Significant" bacterial concentrations occur in "pristine" (ungrazed) areas--some have found very high concentrations; some have found pathogenic strains.
4. No significant nonpoint chemical and physical (temperature, sediment, etc.) pollution related to rangeland grazing.
5. Riparian habitat may suffer because of grazing intensity along streams, resulting in reduced water quality.
6. Grazing increases runoff.

Because of the complex interactive process of the various factors involved, it is difficult to quantitatively evaluate the impacts of livestock grazing on runoff and water quality. Each situation is unique with its own set of interactive complexities, making extrapolation difficult. The overall impact of grazing, however, is to influence in some way the soil-water-vegetative interface (Figure 1). The degree of influence will differ from place to place according to the variable involved.

A review of recent work completed in 1978 and 1979 follows. Additional details may be obtained from BLM-SEA/AR Interim Annual Reports and publications available at the Northwest Watershed Research Center, 1175 South Orchard, Suite 116, Patti Plaza, Boise, Idaho 83705.

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[1] Presented at "BLM Great Basin Watershed Workshop", Stockman Convention Center, Elko, Nevada, November 5-8, 1979.

[2] Geologist, Northwest Watershed Research Center, USDA, SEA-AR, 1175 So. Orchard Patti Plaza, Suite 116, Boise, Idaho 83705.

Boise Front

Map of Boise Front with location of water quality sampling sites is found on Figure 3.

Baseline Water Quality Information

Water quality baseline information continues to be developed from samples collected at four sampling sites on the Boise Front rest-rotation grazing system. The four sites are located immediately upstream from weirs, which record runoff continuously. The sampling sites are located such that the data will reflect the various land-use practices.

Results of analyses of the various water quality parameters are given on Table 3. Total number of samples varies because of intermittent flow at several locations.

Comparing the results of the 1979 data with those reported in 1978, Table 3, differences are very slight. The major differences between sites from the previous year occur because of the rotation in grazing. The fields grazed in 1978 differ from those grazed in 1979. More detailed discussion follows.

Bacterial Indicators From Streams in the Rest-Rotation System

The fall 1978 sheep drive passed through the allotment from October 26 through December 1, using pastures H3, L3, L2, and L1, respectively. In 1979, the spring sheep drive was May 14 to June 2, through pastures H1, L1, L2, H2, and H3, respectively. The approximate course of the sheep drive is given on Figure 3. Cattle were grazed in pasture L3 from April 19 through June 12, and pasture H3 from June 13 through October 1. The remaining fields were rested from cattle grazing during this season. (See Figure 3).

The effect these grazing practices have on the fecal coliform bacteria concentrations is evident by the graphs on Figure 4.

At the Lower Maynard site, in L2, fecal coliform concentrations increased in mid-May as the spring sheep drive passed through. The concentrations remained high until mid-June when the stream went dry. Elevated concentrations in February are the result of deer browsing in the area. The Camp Creek site, located in L3, shows the effect of cattle in the area by mid-April. The fecal coliform concentrations increase abruptly and remain high until the stream dried up by late May. The Upper Maynard site, which measures streamflow from H2, shows the effect of sheep passing through in late May-early June as they moved out of L2. No cattle grazing occurred in this pasture this grazing season. Large concentrations of deer were observed during the winter months above the sampling site. Their presence is probably the cause of the high fecal coliform concentrations from December to March. The deer herd concentrated above this site longer than usual, resulting in fecal coliform concentrations higher than any previously recorded in relation to deer.

Table 3.--Water quality characteristics, Reynolds Creek Watershed sampling sites, 1978-79.

Parameters	Units	No. of Samples (1979)	Maximum 1978	Maximum 1979	Minimum 1978	Minimum 1979	Average 1978	Average 1979
Lower Maynard								
pH	units	17	8.30	8.35	7.5	6.67	7.86	7.73
Conductivity	µmhos	17	190.00	190.00	62.00	60.00	124.64	116.47
Dissolved solids	mg/l	17	131.10	149.97	42.78	54.23	86.00	114.05
Calcium	mg/l	7	—	19.34	—	10.52	—	14.52
Magnesium	mg/l	8	—	2.95	—	2.00	—	2.35
Sodium	mg/l	8	—	15.49	—	3.00	—	7.90
Phosphorous	mg/l	1	—	0.03	—	0.03	—	0.03
Nitrate	mg/l	1	—	0.03	—	0.03	—	0.03
SiO_2	mg/l	3	—	36.00	—	21.50	—	32.78
Sodium adsorption ratio	ratio	7	—	0.92	—	0.18	—	0.56
Suspended solids	mg/l	18	41.20	167.60	2.00	3.00	12.49	21.28
Total coliform	cts/100 ml	21	2000.00	980.00	0.00	0.00	298.19	234.00
Fecal coliform	cts/100 ml	21	1720.00	675.00	0.00	0.00	225.56	81.52
Fecal strep	cts/100 ml	21	305.00	3320.00	8.00	0.00	101.50	431.81
COD	mg/l	8	15.60	6.14	6.30	0.00	8.06	2.89
BOD	mg/l	10	2.00	3.40	0.00	0.00	1.32	1.05
DO	mg/l	17	10.50	10.00	7.00	5.50	8.75	8.35
Camp Creek								
pH	units	4	8.50	8.20	7.40	6.92	7.94	7.68
Conductivity	µmhos	3	190.00	105.00	90.00	100.00	130.78	101.67
Dissolved solids	mg/l	3	131.10	115.92	62.10	99.36	90.24	107.02
Calcium	mg/l	1	—	11.23	—	11.23	—	11.23
Magnesium	mg/l	1	—	2.64	—	2.64	—	2.64
Sodium	mg/l	1	—	9.76	—	9.76	—	9.76
Phosphorous	mg/l	1	—	0.03	—	0.03	—	0.03
Nitrate	mg/l	1	—	0.03	—	0.03	—	0.03
SiO_2	mg/l	1	—	32.00	—	32.00	—	32.00
Sodium adsorption ratio	ratio	1	—	0.68	—	0.68	—	0.68
Suspended solids	mg/l	3	—	19.00	—	3.00	—	11.50
Total coliform	cts/100 ml	16	472.00	775.00	0.00	12.00	165.57	139.67
Fecal coliform	cts/100 ml	16	280.00	528.00	0.00	0.00	38.57	110.33
Fecal strep	cts/100 ml	16	345.00	550.00	4.00	4.00	80.21	124.33
COD	mg/l	—	9.20	—	3.70	—	6.88	—
BOD	mg/l	—	—	—	—	—	—	—
DO	mg/l	3	10.50	10.00	7.50	9.50	8.81	9.67
Upper Maynard								
pH	units	19	8.30	8.20	7.30	6.53	7.77	7.70
Conductivity	µmhos	18	230.00	200.00	49.00	60.00	123.08	110.28
Dissolved solids	mg/l	18	158.70	158.63	33.81	66.65	84.93	110.77
Calcium	mg/l	6	23.45	18.61	18.24	9.10	20.84	12.57
Magnesium	mg/l	7	3.40	2.87	2.92	1.65	3.16	1.92
Sodium	mg/l	7	12.18	8.00	10.58	2.90	11.39	5.65
Phosphorous	mg/l	2	0.05	0.03	0.02	0.03	0.04	0.02
Nitrate	mg/l	2	0.06	0.02	0.04	0.02	0.05	0.02
SiO_2	mg/l	2	36.10	39.55	26.06	20.00	31.08	29.78
Sodium adsorption ratio	ratio	6	0.62	0.59	0.61	0.17	0.62	0.44
Suspended solids	mg/l	19	30.40	23.50	0.00	2.00	7.76	7.63
Total coliform	cts/100 ml	23	1580.00	2300.00	40.00	0.00	433.88	382.13
Fecal coliform	cts/100 ml	23	780.00	1322.00	0.00	0.00	217.35	230.13
Fecal strep	cts/100 ml	23	2005.00	3220.00	10.00	13.00	319.00	368.52
COD	mg/l	10	9.90	13.10	5.10	0.00	7.28	4.80
BOD	mg/l	11	2.50	2.50	0.50	0.00	1.50	0.55
DO	mg/l	19	11.00	10.00	8.00	7.00	8.94	8.24
Highland Valley								
pH	units	29	8.40	8.10	7.41	6.50	7.77	7.52
Conductivity	µmhos	29	173.00	225.00	70.00	70.00	116.36	126.03
Dissolved solids	mg/l	29	119.37	192.51	48.30	82.11	80.29	119.38
Calcium	mg/l	13	17.43	22.37	16.63	10.79	17.03	17.43
Magnesium	mg/l	14	4.50	3.15	4.50	2.30	4.50	2.83
Sodium	mg/l	14	9.89	14.28	9.43	2.80	9.66	9.52
Phosphorous	mg/l	2	0.27	0.16	0.23	0.05	0.25	0.10
Nitrate	mg/l	1	2.00	0.24	0.62	0.24	1.31	0.24
SiO_2	mg/l	3	37.80	42.21	27.27	26.50	32.54	34.61
Sodium adsorption ratio	ratio	13	0.56	0.76	0.52	0.19	0.54	0.58
Suspended solids	mg/l	23	132.40	210.70	2.00	2.00	52.68	23.76
Total coliform	cts/100 ml	33	3770.00	31000.00	0.00	0.00	648.06	3646.75
Fecal coliform	cts/100 ml	33	2020.00	23200.00	0.00	0.00	193.10	1295.06
Fecal strep	cts/100 ml	32	4960.00	99000.00	8.00	0.00	811.21	5655.69
COD	mg/l	10	29.40	39.57	7.80	2.00	15.51	9.61
BOD	mg/l	18	3.00	6.40	1.00	0.00	1.94	1.65
DO	mg/l	29	10.50	9.50	7.50	6.00	8.76	7.76

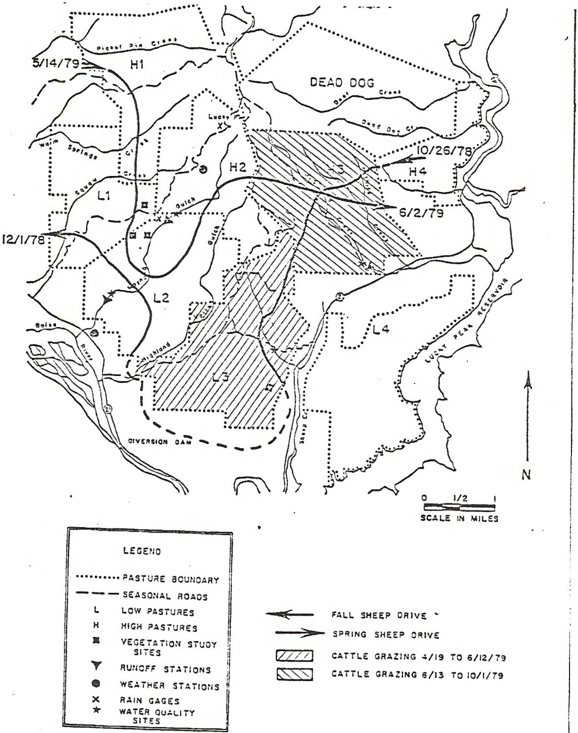

Figure 3.--Boise Front Watersheds indicating approximate course of spring and fall sheep drives and allotments grazed by cattle.

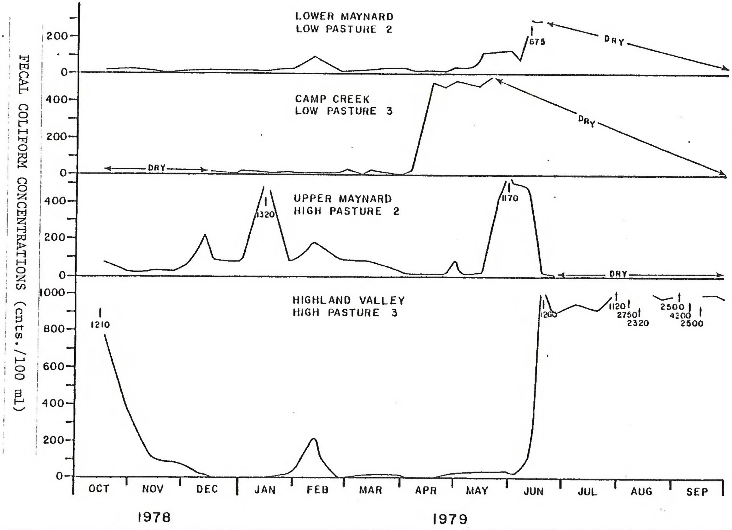

Figure 4.--Fecal coliform concentrations. Boise Front sampling sites.

The Highland Valley site, located in H3, shows high fecal coliform concentrations in October, which is the result of the band of sheep located there at the time. The sheep moved out in late October, resulting in lower fecal coliform concentrations. Cattle were moved out of L3 into H3 by mid-June. Very high fecal coliform concentrations were recorded at the Highland Valley site through the remainder of the grazing season. The cattle were not moved out until October 1. Deer were present above the site throughout most of the winter, especially evident in late January and February.

The different grazing practices of deer, cattle, and sheep each have a significant effect on the fecal coliform concentrations of the streams. One can see in this study the relative effects of each, because there is very little overlap in the presence of the different animals in any one pasture. The cattle, of course, reflect the highest indicator concentration and the deer generally the least. The numbers and distribution of each group vary, causing random concentrations.

Atypical _E. coli_ in Rangeland Streams

In the examination of rangeland stream waters for fecal coliform indicators, pale yellow colonies were found to appear regularly on M-FC medium plates. The standard fecal coliform colony is typically pale to dark blue. In the past, only the blue colonies have been counted as fecal coliforms, as recommended by Standard Methods, the procedure used by most health and water quality labs. The yellow colonies were found to comprise as much as 70 percent of the total colonies on some M-FC plates. In all samples plated more than 80 percent of the yellow colonies identify as _E. coli_ by the AP120E system and serotyping. The atypical yellow _E. coli_ colonies continue to be yellow on M-FC after growth in a nonselective medium. However, 50 percent of the atypical _E. coli_ are ONPG-positive, and 20 percent are EC-positive (44.5°C).

Failure to recognize these atypical yellow colonies as _E. coli_ in water quality analysis could lead to significant errors in the estimation of the quality of rangeland streams.

Bottom Sediment as a Source of _E. coli_ in Rangeland Streams

As a part of the objective to identify nonpoint pollution sources on rangeland streams, stream bottom sediments have been identified as a substantial source of _E. coli_ (Stephenson and Rychert, 1979). Results from samples taken from six separate rangeland streams have shown that _E. coli_ concentrations of bottom sediments were as much as 760 times greater than that of the overlying water. Samples were collected from stream bottoms by simulation, raking the stream bottom, and from one natural runoff event. Figures 5, 6, and 7, and Tables 4 and 5 give the results. This work suggests that microbiological analysis of sediments should be a part of rangeland stream water quality evaluations. Since sediment may be a significant source of fecal micro-organisms, even in the absence of grazing or during the post-grazing period, even minor disturbances of the organic bottom mass at the stream sediment interface can cause resuspension of the _E. coli_ or other indicators, causing increased pollution of the overlying water body.

The manuscript reporting on this work is presently in review status.

The Highland Valley site, located in H3, shows high fecal coliform concentrations in October, which is the result of the band of sheep located there at the time. The sheep moved out in late October, resulting in lower fecal coliform concentrations. Cattle were moved out of L3 into H3 by mid-June. Very high fecal coliform concentrations were recorded at the Highland Valley site through the remainder of the grazing season. The cattle were not moved out until October 1. Deer were present above the site throughout most of the winter, especially evident in late January and February.

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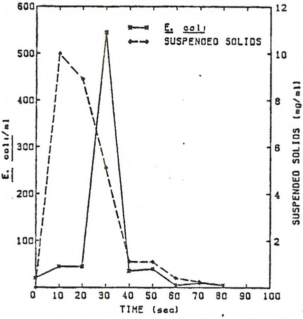

Figure 5--Disturbance simulation, June 19. Highland Valley Creek.

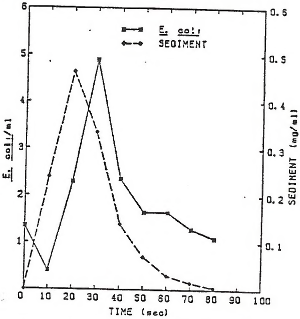

Figure 6--Disturbance simulation, July 24, Reynolds Creek 0-56 site.

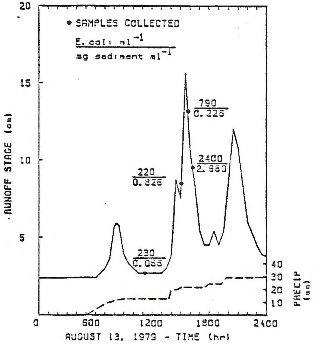

Figure 7--August 13, Cottonwood Creek Hydrograph.

Table 4.--E. coli sediment and overlying water concentrations.

Sample	Date	Creek Site		E. coli/ml	Sediment/Water Ratio	mg sediment/ml	E. coli/gram sediment
sediment	21 May	Reynolds 056		6.1	31	93.8	65
water	21 May	Reynolds 056		0.2	---	<0.1	---
sediment	12 July	Reynolds-056	1*	4.5	10	14.5	310
water	12 July	Reynolds-056		0.45	---	<0.1	---
sediment	21 May	Reynolds-036		33.0	37	161.8	204
water	21 May	Reynolds-036		0.9	---	<0.1	---
sediment	11 June	Lower Maynard		813.3	145	94.8	8579
water	11 June	Lower Maynard		5.6	---	<0.1	---
sediment	11 June	Highland Valley		97.8	51	158.4	617
water	11 June	Highland Valley		1.9	---	<0.1	---
sediment	19 June	Highland Valley	2*	263.0	11	125.4	2097
water	19 June	Highland Valley		23.0	---	<0.1	---
sediment	25 June	Highland Valley		594.0	43	160.8	3694
water	25 June	Highland Valley		13.8	---	<0.1	---
sediment	12 July	Highland Valley		73.0	3	16.0	4563
water	12 July	Highland Valley		24.0	---	<0.1	---

* Site use

1. Irrigated pasture - winter livestock feeding.
2. Heavily grazed - Livestock and big game.

Table 5.--E. coli sediment and overlying water concentrations and sediment organic carbon percentages.

Sample	Date	Creek Site		E. coli/ml	Sediment/Water Ratio	mg sediment/ml	E. coli/gram sediment	% organic carbon
sediment	24 July	Reynolds-056		165.0	127	205.8	802	4.3
water	24 July	Reynolds-056		1.3	---	<0.1	---	---
sediment	9 August	Reynolds-056	1*	152.0	760	232.0	655	4.9
water	9 August	Reynolds-056		0.2	---	<0.1	---	---
sediment	2 August	Highland Valley	2*	137.0	17	37.0	3702	7.7
water	2 August	Highland Valley		7.9	---	<0.1	---	---
sediment	2 August	Rabbit		1.9	>10	71.0	27	3.1
water	2 August	Rabbit		<0.18	---	<0.1	---	---
sediment	2 August	Mores	3*	2.8	>15	56.7	49	0.7
water	2 August	Mores		<0.18	---	<0.1	---	---
sediment	2 August	Grimes		1.5	8	7.3	205	0.6
water	2 August	Grimes		0.18	---	<0.1	---	---
sediment	2 August	Boise River	4*	0.5	>2	3.0	167	0.7
water	2 August	Boise River		<0.18	---	<0.1	---	---

*Site use

1. Irrigated pasture - winter livestock grazing
2. Forested - Big Game - moderate livestock grazing
3. Heavily grazed - Livestock and Big Game
4. Mostly Urban - some grazing

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Stephenson, G. R., and R. C. Rychert. 1980. Bottom sediment: A source of *E. coli* in rangeland streams. Manuscript in review process for publication.

BLM GREAT BASIN WATERSHED WORKSHOP
STOCKMEN's CONVENTION CENTER, ELKO, NEVADA
NOVEMBER 6, 1979

Jack C. Chugg, Soil Scientist, Resource Inventory Staff, DSC

SCS/BLM COORDINATION AND QUALITY CONTROL FOR SOIL SURVEYS ON PUBLIC LANDS THAT THE BUREAU ADMINISTERS

Mandates through legislative acts have set the course for resource inventory of the natural resources for the Bureau: FLPMA for instance, states that "the Secretary shall prepare and maintain on a continuing basis an inventory of all public lands and their resources and other values ...., giving priority to areas of critical environmental concern. This inventory shall be kept current so as to reflect change in condition and identify new and emerging resource and other values". (sec 201). Further along in section 202, the Act becomes more specific. It says, (1) "Use and observe the principles of Multiple Use, (2) Use a systematic interdisciplinary approach to achieve integrated consideration of physical, biological, economic and other sciences and (3) coordinate with other federal and state agencies in land use inventory, planning and management."

This Act and others has caused the Bureau to evaluate Bureau inventory systems for the natural resources that we manage. The resource data needed to develop Environmental Statements for Range and Coal as well as active plans caused the development of the Soil Vegetation Inventory Method (SVIM). This became accepted procedure for the Bureau. SVIM established policy for gathering soil and vegetation data within the Bureau. The wide range

of interpretations that can be made from this data has great utility in the management of all of the nearly one half billion acres that the Bureau administers. The principles of SVIM are equally applicable without exception in Alaska and the eastern states as it is in the Western United States.

The Bureau, as a member of the National Cooperative Soil Survey, accepts the standards set forth by this organization. Other members are the Soil Conservation Service, Geological Survey, Forest Service, and the Fish and Wildlife Service. ([illegible]) The purpose for this organization is to establish a common base for exchange of soil and vegetation data without duplication of effort. With this kind of charge, and the SCS's responsibility for soil correlation, coordination and quality control for soil surveys becomes a very large and difficult management problem under the restraints (funds, work force, work load, court orders, etc.) that the Bureau must operate.

Beginning in 1978, when SVIM became operational, problems in coordination and quality control in soil surveys on 131 million acres began to surface and be identified. Some of the problems were anticipated, resulting in the issuance of the Instruction Memorandum No. 78-315, Soils-Long term Planning. The response from the states was mixed and difficult to analyze in an orderly manner. It was not all bad because administration did respond in some manner to the most obvious deficiencies, such as, developing a scheme for quality control with the SCS West Technical Service Center, establishing better liaison with SCS Washington Office and obtaining BLM

State Soil Scientists in all the Bureaus' states except the ESO. This is to name only a few of the actions taken.

Again, in 1979 there was an issuance of Instruction Memorandum No. 79-601, Soils-Long Range Soil Survey Work Plan. The purpose was not only to more closely identify the work load, but to identify the problems of coordination and quality control for management of soil surveys. From the analysis of the long range soil survey on a national basis the following problem areas in correlation and quality control were identified.

The most significant problem that occurs throughout all the soil surveys is quality control. Soil Conservation Service and private firms are having great difficulties in meeting the requirements of the Statement of Work (SOW). This is due, in part, to the short time frames imposed upon the completion of the soil survey for large areas by the Bureau. Some solutions to this problem will be suggested later.

The next most important problem area is locating and making available qualified soil scientists and range conservationists in sufficient numbers that can do this kind of work within the time frames imposed by the Bureau. It is indicated by the plan that if the Bureau and SCS had about 135 full time soil scientists available for mapping at a rate of 150,000 acres per season (100 days), the Bureau could meet their 20.3 million acre goal in Fiscal Year 1980. It also would require about 18 additional highly qualified, full time, soil scientists to maintain

quality control and 10 more for correlation of the survey. This totals to 163. It is not a question of whether the Bureau or SCS have the numbers of soil scientists, it is how this expertise is being utilized in the Bureaus soil survey activities.

Quality control is very difficult to attain when short time frames are imposed for gathering soil and vegetation data. This problem is most evident in Wyoming, Utah, Nevada and California. The Bureau has yet to receive a soil survey report that totally meets the requirements of the statement of work or of the National Cooperative Soil Survey. The documentation procedure for soil surveys requires more time than now allowed to adequately describe, classify, interpret, and correlate named and unnamed soil series. This procedure is long and complex. When as much as one half of the Bureau lands are located in such areas, this intensifies the problem of quality control and correlation.

There are several (7) actions that the Bureau could initiate to ease these problems in soil surveys as stated. These are:

(1) The Bureau and SCS develop a standardized statement of work (SOW) for Interagency Agreements (SCS) and Request for Proposals (RFP) (Contracts). The Bureau, Soil Conservation Service and Contractor are basically after the same kind of soil and vegetation data everywhere without exception. There will be some flexibility to allow for objectives of the soil survey. When the SOW is prepared for a soil survey area copies will be forwarded to the State Director

(BLM) and to the State Conservationist (SCS) for coordination and quality control.

(2) All soil surveys on public lands will contain a Certificate of Correlation by the SCS before acceptance by the Bureau. This document will be available within 90 days after completion of the field work. This document is supporting information that insures that the requirements of the National Cooperative Soil Survey are met, as well as the requirements for the Bureau's planning system and for Environmental Statements.

(3) The quality control procedures for soil surveys needs to be standardized as a separate section in the SOW. The procedures will be the same among the states. The SCS will participate in all (1) TEPC's, (2) pre-work conferences and (3) field reviews. When the Bureau is doing in-house soil surveys, the SCS will participate in the field reviews. This is necessary to identify the principal individuals involved in the soil survey, as well as, to develop schedules and documents for each stage of progress in the survey as stages to soil and range site correlation.

Based on the 3 problem areas listed above, the Bureau (Chugg) and the SCS (Dierking) will draft a Statement of Work (SOW) and develop a guideline for field Quality Control the week of November 26th, 1979. These will be circulated to the field for review and comment in January, 1980. The draft will be finalyzed by February 28, 1980. These

documents will be used as a basis for the Fiscal Year 81 and future procurements for soil surveys.

(4) Equipment support for soil surveys, such as helicopters, fixed wing aircraft, backhoes, field test kits, LANDSAT scenes, Black and White, color or Color Infra Red stero photos, orthoquads or topographic base maps for the SCS or Contractor should be supplied by the Bureau. This kind of support greatly speeds up the surveys as well as improve quality control.

(5) The time frame in which many soil surveys are now being conducted is far too short for adequate quality control and correlation. It is suggested that (1) the survey areas be reduced in size to about 500 to 700 thousand acres to more easily manage and document. When acreages are a million or more then one should extend the activity over 2 or more field seasons for ES areas or Planning Units after FY 81 or 82.

(6) The RFPs must be prepared and sent to the Contracting Officer for processing at the beginning of the fiscal year. It really does require 80 to 120 days to award the contract. The designated Contractor must have sufficient time before the field season to complete the research necessary to do the soil survey. This allows him time to document his findings for quality control and correlation without continually reviewing literature during the progress of the survey.

(7) The SCS will be designated as a permanent member of the Technical Proposal Evaluation Committee. The purpose is for quality control management and correlation as required in the NCSS.

I expect the Washington Office to issue appropriate Instruction Memorandums covering the above subjects by April 1, 1980.

Mr. Richard Dierking, Soil Scientist, SCS, West Technical Service Center, Portland, Oregon, will be the soil correlator for Public Lands that the Bureau administers in the Western States and Alaska. His office will issue the Certificate of Correlation.

There are some other items that need consideration that could speed up the soil surveys.

* Ed

(1) The Bureau needs to re-examine the intensity of soil surveys to meet the objectives in selected areas where there are low value land uses. It is suggested that the principle states in SVIM form·the basics for the inventory, but the only change would be in the mapping scale and minimal size area. The map scale could be increased to 1:48,000 or 1:63,360 or 1:80,000. The amount of detail lost from 1:24,000 will not usually be significant in low value land use areas. The field mapping is transferred to field sheets and recorded on 1:24,000 scale. Then this is consistent with the Bureaus' resource data base (SVIM).

(2) When there is a direct interchange of soil and vegetation between agencies there is a need to hold periodic interagency workshops or conferences. This is especially true between the BLM and SCS. Often field parties do not fully understand the SVIM data gathering procedure, the compilation process, and the relationship to DRD. This is a form of quality control as well as training. The target group is BLM COAR's and field representatives, SCS/BLM leaders of inventory groups, planners and managers that are directly associated with SVIM in that particular year. Some or all of these people help or influence the data gathering process and compilation. The benefits of such a conference would greatly improve quality control in the SVIM operation.

(3) The Bureau needs to develop a catalog of statements that meet the requirements of the planning system. This can be done through the SCS's Computer Assisted Writing system. This would greatly speed up (approximately 50%) the soil survey report manuscript preparation and editing. The SCS has indicated that they would assist the Bureau in developing such a catalog. The benefits are too large to pass over. It is suggested that all of the Bureau's State Soil Scientists meet in Portland, Oregon to develop the catalog. This location is near the SCS computer and expert. This should be done before April 1, 1980.

(4) The Bureau also needs to develop a Soil Interpretations Recorded patterned after the SCS Soils-5. The Bureau makes other interpretations not made by the SCS. The SCS has indicated that they would assist the Bureau in developing this record for the Bureaus' use.

(5) Soil Scientist training is and has been a continuing problem for the Bureau. Training is necessary to be professionally proficient. Junior grade soil scientists should be assigned to SCS soil survey parties for the field experience. Higher grade soil scientists should have the opportunity to attend courses put on by the SCS at the WTSC. These are correlation and classification, soil mechanics, manuscript writing, soil laborata data use, basic soil survey and Soil Science Institute at Iowa State University or Cornell University.

(6) The Long Range Soil Survey Plan is a document that needs to be kept current for management of the soil surveys. The Bureau's Land patterns, in some instances, present problems as to how to efficiently map them. These patterns could be classified into 3 categories, each present a different set of logistic and funding strategies. These patterns could be classified into block, scattered block, and intermingled. This classification becomes important when the Bureau can only pay for soil surveys on lands that we manage. A state map at a scale of 1:500,000 showing land status as a base for an overlay of the Bureaus' soil survey area would be very useful in determining the contents of the soil survey plan for each area. The Soil Conservation Service WTSC and DSC have a need for such a overlay ih analyzing the long range soil survey plan and for close coordination with the SCS.

There are some other interesting bits of information covering soil survey costs, accomplishment and numbers of soil scientists by state in FY 79.

Table 1 - Program and Cost Report. September 30, 1979
(Summary of soil surveys in FY 79)

States	Planned (AC 10^6)	Reported (AC 10^6)	Diff.	Goal (%)	Cost (per AC.)
West.	20.2	16.8*	3.4	83	0.25*

* All Soil Surveys not reported

Table 2 - Numbers of BLM Soil Scientists, August 1979

State	Grade						Total
Bureau-wide	13	12	11	9	7	5	
	2	19	41	29	22	9	122*

* 3 Vacancies, 28 WAE, 6 temporaries, 2 LWOP, 83 permanent

Soil Interpretations

Ed Naphan - State Soil Scientist
Reno, Nevada

The application of soil science in soil classification, soil mapping, and soil interpretations is involved with a systematic consideration of a multitude of facts. The Soil Survey Manual (A.H. No. 18) points out that although soil science is dependent upon facts from the chemical, physical, biological, and earth sciences, it cannot be considered to fit neatly with any of these--it is all of them, but not any one exclusively.

Any of the theories, laws, or principles that we develop in work with soils must stand the test of all the evidence that any of the basic sciences can bring to bear. They must be consistent with all the laws of chemistry and physics if they are to survive. In soil science we therefore follow closely the scientific method that includes:

1. The collection of facts - research, experience, observations, etc.

2. We generalize facts into theories that explain soil genesis and soil behavior.

3. We test our theories by subjecting them to tests of all evidences from other sciences and other fundamental and applied branches in soil science.

4. By the process of deductive thinking we use established theories and principles to make inferences regarding all sorts of information pertaining to the behavior of the soils that would otherwise be unknown or go unnoticed. Thus,as in other sciences, we have the gift of prophesy or basis for making predictions regarding soil characteristics, soil properties, and soil behavior under different uses and combinations of manipulative practices.

Predictions or soil interpretations are perhaps one of the greatest end results of the use of the scientific process in soil science. Their accuracy and reliability are greatly dependent upon the level of our technical knowledge and competence and experience of the personnel applying this knowledge.

Purpose and Scope of Soil Interpretations

As has been pointed out, soil interpretations are basically the application of the scientific method of making predictions from established facts and theories. The basic purpose for soil interpretations is to provide to users of soil maps predictions about the behavior of each kind of soil

under defined situations--particularly systems of soil use and methods of manipulation. The interpretations range from such specific items as drain spacing, erodability, suitability for highway subgrades to more broadly defined qualities such as soil productivity for groups of crops, suitability for forest products, wildlife, etc. The more precisely we define alternative conditions of soil use, the more specific we can make the predictions of the results. Most commonly the users of soil surveys want to know how the soils on a tract of land can be expected to behave. Other users want information for broad areas or for one or more specified soils wherever they occur. Also more and more the users of soil surveys want quantitative rather than qualitative information about soil behavior as well as soil characteristics and properties.

Soil survey interpretations are broad in scope. They may include numerous kinds of interpretations that apply to agriculture, forestry, range, biology, engineering, hydrology, recreation, urban, and industrial uses of soils. Especially significant in recent years is a consideration of the effect of soil use in relation to impacts on other resources, i.e., water, air, aesthetics, plant, climate, and the soil itself. As a consequence, adverse effects become critical criteria in present interpretation guides; whereas 15-20 years previously, they were given little or no attention.

Relationship of Soil Classification to Interpretations

Interpretation is a natural scientific process which results from soil classification and correlation. It follows then that the reliability of interpretations is dependent upon the reliability of our classification and correlation process.

The reasoning for this relationship is that the soil classification system attempts to take into account all of the characteristics relevant to all the needed interpretations, not simply one or two of them. Our soil survey must serve many purposes. Any single interpretive grouping should be far simpler than the classification system, else it would have little or no advantage for direct use.

A kind of soil is a collection of all the individual soils in the world, wherever they are, that are alike according to the definitions that we write. We can speak of kinds of soil at a low level in our classification system such as the soil series or at a high level such as great groups, suborders, or orders. We must understand however, that the definitions which we prepare are based on combinations of soil characteristics. A specific kind of soil is defined on the basis of a great number of characteristics existing together, each one influencing the effect of the others. No soil can be defined on the basis of one,

two, or any other limited number of characteristics because it will fail to satisfy the objective of soil classification in relation to accounting for all characteristics relevant to needed interpretations. Consequently, it becomes obvious that soil interpretation is intimately related to classification and correlation. This is the major purpose of soil correlation in the first place since soil classification and correlation is the basis for accurately extending research and experience on known taxons to similar ones at other locations.

This of course stresses the importance of accurate soil classification. Without a practically and scientifically sound soil classification, interpretations will be vague or even wrong. On the other hand, soil interpretations help to test the classification.

Nothing is permanent including our soil classification system, yet it is much more nearly so than our interpretations from it. As we learn more about soils, the new knowledge must be worked into the soil classification so that we can make additional interpretations and more precise ones.

Guidelines For Making Soil Interpretations

All soil interpretations are based on guidelines and criteria developed by interdisciplinary groups. Such guides are usually subjected to widespread review and testing prior to implementation. This results in widespread coordination and acceptance across a spectrum of many disciplines and agencies and groups concerned with making and interpreting soil surveys.

Interdisciplinary effort is essential--it results in acceptance of the interpretations by specialists in other fields, and greater confidence in the reliability of the interpretations by users of soil surveys.

An additional factor is the necessity for wide review and testing of criteria and guides. This provides an opportunity to obtain additional interdisciplinary input and sharpens up the criteria and guides. It also assures coordination because those using the guides have a better appreciation and understanding for the purpose and objective for the guidelines.

Lastly guides provide a means to supply users with information relative to how specific interpretations were made. The availability of this data is becoming increasingly important when the results of soil surveys are challenged in and outside of courts.

Formats for soil interpretations take many forms:

1. Soil qualities - Behavioral properties which result from the interaction of soil characteristics--fertility, available water capacity, permeability, shrink-swell are examples.

2. Soil groupings - Groupings of soils having similar characteristics and potentials for specific purposes--land capability classification, irrigability classification, irrigability classes, wetland groupings, groupings of stony soils, sandy soils, etc.

3. Suitability ratings - Ratings of soils by general statements pertaining to their suitability for specific purposes. Suitability ratings for specific plants, sources of sand, gravel, topsoil are examples.

4. Limitation ratings - Ratings that express relative degrees of hazards, risks, or limitations for natural or essentially undisturbed soils for specified uses. Ratings for sewage lagoons, excavations, septic tank filter fields, roads, etc., are examples.

5. Features affecting specific uses - Listing of soil characteristics, properties, and qualities that effect specific uses or practices. Used mostly for engineering uses such as for embankments, drainage and irrigation, terraces, diversions and many others.

Soil interpretations are designed to convert information about soil characteristics and properties into easily comprehendable data about the usefulness of different kinds of soil for different purposes. They should in no way preempt planning decisions nor are they recommendations for planning. They are used by planners to consider alternatives for planning and a means to evaluate impacts (adverse and beneficial) which result from each alternative. When used in this context, interpretations are very useful. In fact we find planners frequently going further--they may develop guides in which our interpretations along with other factors become criteria to provide a basis for developing plan alternatives.

Future Emphasis in Soil Interpretations

The future demands for soil interpretation will include the following:

1. Greater emphasis on quantitative interpretations - Tons per acre per year of soil erosion under specified condition of land use and treatment; yield of crops, pasture, hay, range, woodland, etc., under specified use, management, and manipulation.

2. Greater emphasis on soil potentials - What needs to be done to convert or improve soil use for specific purposes and what can be expected from such programs.

3. Greater emphasis on competence to investigate and make decisions for siting structures, practices, land use conversions. The on-site decisions will require considerable competence because large investments of funds may be involved and the consequences of actions require careful evaluation in relation to benefits and adverse impacts.

4. Identification and implementation of research needs. Also application of research and experience in criteria for interpretations, and if needed revise the soil classification system so that taxons at proper levels provide information for interpretations. In other words we need to continually improve our soil classification system and criteria for interpretations so that they are current with respect to our technical knowledge.

COAR & Project Inspector Responsibilities in Soil Inventory Contracts,
Jerry Harmon, Soil Scientist, NSO, BLM (edited from notes)

l. Makes final inspection and acceptance on behalf of the Government.

m. Reviews and signs contract payment certificates, certifying to the contracting officer that they accurately reflect the work done.

n. Submits all required progress reports to the contracting officer and otherwise keeps the contracting officer fully informed on all phases of the contract.

B. Project Inspector. Each contract for construction or other services requires direct and continuing inspection. To perform these functions, a project inspector is designated. The project inspector has immediate contact with the contractor, inspects the work while it is in progress, and enforces the contract's terms. The project inspector is the most important person in the contract administration team because of his/her close, direct association with the contractor and the work. Most contract problems stem from an action or failure to act by the project inspector, either because of a lack of knowledge or an inability to perform fully required duties.

1. Selecting the Project Inspector. The originating official nominates the project inspector on Form 1510-5, together with a nomination for the COAR. The COAR may serve in both capacities if circumstances warrant; however, this would be unusual. For major building projects, inspection personnel will be nominated by the Service Center Chief, Division of Engineering, based on State Office recommendations and other pertinent factors.

a. Qualification Requirements. Personnel whose work will require them to perform as project inspectors on construction contracts must attend the Bureau's Basic Construction Inspection Course and be certified as inspectors before they may be nominated for work on routine construction such as fences, wells, small dams, water distribution, etc. For more complicated construction projects, major dams, roads, large recreation projects, etc., advance training is required as a prerequisite for nomination. (See BLM Manual Section 9103.) As in the case of the COAR, these personnel should be encouraged to attend other courses in contract administration. The contracting officer may reject any nominee for project inspector if, in the contracting officer's opinion, that person lacks the required background or training, or has demonstrated a lack of conscientiousness on past contracts. All project inspectors must have a good working knowledge of this Manual Section. Project inspectors on nonconstruction projects must have attended the Bureau's contract administration course.

2. Principal Duties and Responsibilities. Since quality of work accepted rests directly on the shoulders of the project inspector, his/her performance is the most critical part of administering a contract for construction or other services. The inspector, by improper or undue actions or by failure to act when required, can seriously harm the Government and the contractor. Accordingly, the inspector assumes considerable responsibility. In general, the project inspector's duties are:

a. Maintaining the contract's Inspector's Log, Form 9100-1.

b. Inspecting the work for compliance with contract terms, specifications, and drawings.

c. Conducting required field tests (compaction, alignment, verifying materials certificates, etc.).

d. Initiating or recommending initiation of requests for change orders.

e. If authorized by the COAR, issuing Instruction to Contractor (Form 9100-1c), needed to assure performance in conformity with contract terms. (See Illustration 36.)

f. Conducting on-site interviews with a contractor's employees in connection with labor standards provisions enforcement.

g. Checking the contractor's plant and equipment to be sure that they are in good operating condition and that they comply with applicable OSHA standards. Where equipment rental is involved, verifying that the contractor's equipment meets all minimum requirements.

h. Checking camp areas for sanitation and compliance with OSHA and Service Contract Act safety requirements.

i. Checking operations for compliance with OSHA and Service Contract Act safety requirements.

j. When authorized by the COAR, issuing stop and resume work orders.

k. Making measurements for payments.

l. Conducting field investigations of labor compliance complaints received at the local level.

m. Auditing contractor's payrolls; making sure that they are filed weekly on construction work.

n. Reporting to the COAR on all problems anticipated or encountered and remedies taken or recommended.

o. Furnishing the COAR information needed in the case of disputes or protests so that the COAR can either make a decision or advise the Contracting Officer.

p. Making on-site interpretation of specifications for the contractor when necessary. In case of disputes or protests, referring to the COAR for decision or further referral to the Contracting Officer.

q. Preparing all required progress reports for the COAR and for the Contracting Officer.

C. Contracting Officer. The Contracting Officer is the final authority and is ultimately responsible on all contractual matters. The Contracting Officer has a direct administrative relationship with the COAR and with the project inspector insofar as contract administration is concerned. However, this does not diminish the District Manager's or other office head's responsibility for overall program management. Knowledge of contractual progress and problems is essential, and it is imperative that the COAR keep the office head informed of project developments and progress. The Contracting Officer and contract administration team of COAR and project inspector are, in effect, working directly for the originating office head to get programmed work performed. In this respect, it is the Contracting Officer's responsibility to assure that the contract program is carried out expeditiously and effectively, and in accordance with the laws and regulations which apply. The COAR and project inspector assist the Contracting Officer in the above functions. The Contracting Officer's principal responsibilities are to:

1. Furnish the contractor with all required posters and materials at the time of award.

2. Designate the COAR and project inspector in writing, and clearly describe their duties and responsibilities.

3. Provide the COAR with all required special instructions; make sure that the COAR has required copies of specifications, and in the case of major projects, make sure that full-size prints of project drawings are available.

4. Negotiate major contract modifications and give final approval on all modifications.

5. Assess liquidated damages or excess costs.

6. Terminate the contract.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
DENVER SERVICE CENTER
DENVER FEDERAL CENTER, BUILDING 50
DENVER, COLORADO 80225

IN REPLY REFER TO
1510 (D-553

9/26/79

JAN 1 9 1980
Bureau of Land Management
Idaho State Office

September 24, 1979

Memorandum

To: Jerry Harman, Nevada State Office

From: Russell K. Fromholz, Contracting Officer, D-553

Subject: Appointment as Contracting Officer's Authorized Representative

1. You are hereby appointed as a Contracting Officer's Authorized Representative (COAR) under Contract No. YA-512-CT9-260.

2. This appointment shall remain in effect for the life of the contract unless:

a. The appointment is terminated in writing by the undersigned Contracting Officer or by his successor Contracting Officer; or,

b. You are reassigned; or,

c. Your employment with the Government is terminated.

3. You shall represent the Contracting Officer for all technical matters that arise under the aforesaid contract. In this respect, Federal Procurement Regulations require that you:

a. Shall familiarize yourself with the terms and conditions of the contract and particularly those which fall within the area of your authority.

b. Shall remain cognizant of the Contractor's technical efforts and progress and discuss these matters with him, as appropriate.

c. May respond to the Contractor's inquiries on purely technical aspects of the contract.

d. Under cost reimbursement contracts, shall exercise appropriate surveillance of the Contractor's performance to be reasonably assured that the Contractor is not using inefficient or wasteful methods.

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e. Shall review Contractor's progress reporting to determine if there has been technical and/or physical progress commensurate with the level of expenditures.

f. Shall advise the Contracting Officer of any unusual problems affecting the progress or cost of the contract.

g. If designated to do so in the contract document, you shall inspect the supplies/services delivered for conformance with the contract work statement and specification requirements and make acceptance of or reject for cause such supplies/services.

4. Notwithstanding the authorities delegated in paragraph 3, above, you:

a. Shall not redelegate any authority to any other person;

b. Shall not change any of the terms or conditions of the contract or sign any modification to the contract;

c. Shall not obligate the payment of any money by the Government;

d. Shall not cause the Contractor to incur costs, not otherwise covered by the contract, with the expectation that such costs will be reimbursed by the Government.

5. Contact the Contracting Officer for guidance in the event you are in doubt as to the extent of your authority or in any circumstance not covered above.

6. Forward to the Contracting Officer a copy of all correspondence initiated by you to the Contractor. This shall include memorandum of verbal discussions of a significant nature.

Russell K Fromholz

cc: SALUT

"Preliminary Comparison between Soil Loss Estimates Using the Universal Soil Loss Equation and the Associated "T" Value"

Dick Page, Watershed Specialist
Utah State Office

Part of BLM's multiple resource management program is the maintenance and/or improvement of its watersheds. A more complete identification of basic watershed maintenance requirements for the various ecological units being identified through the Soil/Vegetation Inventory Method (SVIM) Survey appears to be available through use of the Universal Soil Loss Equation (USLE) and its associated "T" value. It is the objective of this paper to review the potential for applying this comparison as an aid in determining watershed maintenance requirements.

Soil loss estimates made using the USLE consider rainfall, soil erodibility, percent slope and length, and cover. These are basic ecological factors to be considered in managing BLM's watersheds. Soil loss tolerance ("T" value) which is the maximum rate of soil loss that can be sustained and still maintain crop productivity indefinitely, is also available for each soil series. A comparison therefore, between soil loss occurring under field conditions as estimated using the USLE and its associated soil loss tolerance value, will show whether or not watershed productivity is being maintained. Some general guidelines on this comparison were made by LaMar Mason, SCS State Range Cons. in June 1978 (publication is entitled "Soil Losses from Utah Rangeland and Forestland").

The following study is our first effort to determine how close the USLE/"T" value comparison can be used to determine watershed maintenance conditions. The percent slope and length factor as identified in the SCS (Utah) January 1976 publication for determining soil loss through the USLE, was modified as follows:

$$LS = \left(\frac{L}{72.6}\right) .3 \times \left(\frac{S}{9}\right) \quad 1.3$$

Dr. Don McCool has determined this correction factor is needed on rangelands where slopes are greater than 9%.

"Paper prepared for presentation at November 5-8, 1979 BLM Great Basin Watershed Workshop - Elko, Nevada".

COMPARATIVE ANALYSIS SHOWING ESTIMATED
SOIL LOSS (TONS/AC/YR), ASSOCIATED TOLERABLE SOIL LOSS ("T" VALUE),
AND OTHER SOIL-VEGETATIVE INVENTORY DATA FOR SOME SOIL SERIES IN
THE VERNAL BLM DISTRICT

SOIL SERIES	SOIL DEPTH	SLOPE LENGTH	% SLOPE	ESTIMATED SOIL LOSS (TONS/AC/YR) USING THE UNIVERSAL SOIL LOSS EQUATION					"T" VALUE	SOIL SURFACE FACTOR (SSF)	RANGE SITE & TENTATIVE CONDITION
				MIN SLOPE & LENGTH	MIN SLOPE & MAX LENGTH	MAX SLOPE & MIN LENGTH	MAX SLOPE & LENGTH	MEAN SLOPE & LENGTH			
UTALINE LOAM	V DEEP 60"	SHORT < 300'	0-2	.1	.1	.2	.2	.1	2	34 RANGE1/ 25 SOILS 1/	DESERT LOAM LOW POOR
UTALINE VARIANT-BADLAND COMPLEX COBBLY LOAM	M. DEEP 23"	SHORT <300'	15-40	1.5	1.7	5.0	5.6	2.5	2	22-RANGE 50-SOILS	DESERT LOAM COMPLEX FAIR
MOENKOPI ROCK OUTCROP SANDY LOAM	SHALLOW V SHAL. 8"	MEDIUM 300' - 800'	2-15	.2	.2	1.5	2.0	1.3	1	32-RANGE 22-SOILS	DESERT SHALLOW LOAM LOW-FAIR
CURHOLLOW VARIANT LOAM	SHALLOW 16"	MEDIUM 300' - 800'	4-8	.4	.7	1.2	2.0	1.4	1	33-RANGE 39-SOILS	SEMI DES SHALLOW HARDPAN HIGH FAIR-LOW GOOD
ROOTEL VAR. GRAVELLY LOAM	M. DEEP 29"	MEDIUM 300' - 800'	3-8	.3	.4	1.2	2.0	1.1	1	25-RANGE 39-SOILS	SEMI DES LOAM FAIR

				ESTIMATED SOIL LOSS (TONS/AC/YR) USING THE UNIVERSAL SOIL LOSS EQUATION							
SOIL SERIES	SOIL DEPTH	SLOPE LENGTH	% SLOPE	MIN SLOPE & LENGTH	MIN SLOPE & MAX LENGTH	MAX SLOPE & MIN LENGTH	MAX SLOPE & LENGTH	MEAN SLOPE & LENGTH	"T" VALUE	SOIL SURFACE FACTOR	RANGE SITE & TENTATIVE CONDITION
BROWNSTO GRAVELLY LOAM	V DEEP 60"	MEDIUM 300'-800'	8-15	2.0	3.1	3.0	4.1	2.7	1	40-RANGE 36-SOIL	SEMI DES. LOAM FAIR
SINKSON VARIANT V.COBBLY CLAY LOAM	M DEEP 34"	SHORT <300'	15-50	2.7	3.0	14.0	15.8	13.8	2	45-RANGE 58-SOIL	SEMI DES. LOAM-FAIR
LUHON GRAVELLY LOAM-ROCK OUTCROP COMPLEX	V DEEP 60"	SHORT <300'	40-60	5.7	6.4	9.6	10.8	8.53	5	31-RANGE 64-SOIL	UPLAND LOAM J/P POOR
ROCK OUTCROP NIPPT VAR. COMPLEX	V SHALLOW 8"	MEDIUM 300'-800'	15-25	.7	.9	1.2	1.6	1.1	1	66-RANGE 59-SOILS	UPLAND V.SHALLOW LOAM J/P GOOD

1/ = RANGE RATING DETERMINED BY SVIM CREW; SOIL RATINGS BY SOIL SCIENTISTS

Tentative Conclusions:

1. Erosion on soils of varying depths (especially shallow/very shallow) are quite likely to equal or exceed their associated tolerable soil loss limit under various management conditions.

2. Estimated soil loss on low conditioned range sites are often equal to or more than the associated tolerable soil loss limit.

3. Correlation between SSF rating and an excessive soil loss is not good. Estimated soil losses often exceed their "T" value even though slight to moderate watershed conditions have been determined.

4. The protective influence of rock cover in maintaining watershed stability does not appear to have been adequately accounted for in the USLE. Further effort/study to accurately determine the effectiveness of rock cover in maintenance of our watersheds is needed.

5. Analysis of the USLE estimated soil losses and its associated "T" value on comparison and managed watersheds may be a viable management tool and should receive further consideration.

These conclusions offer support and need for developing/adapting the USLE to evaluate BLM's native watershed conditions to serve as an important management tool.

Dick Page

Ground Water Evaluation in Land Use Planning - Rick Banta, Hydrologist, Oregon S.O., BLM (edited from notes)

- Identify data gaps.
- Utilize the level of inventory necessary for your particular need. (Level 3 - URA, Level 1 most concise) See 7211 Manual.
- Consider important areas such as effects of strata on groundwater quality.
- Collect as much information as possible, such as well-pump information, depth and draw-down, USGS reports, drillers' reports, water rights and well drilling applications, etc.

For further information contact the DSC groundwater geologist, Paul Summers, FTS 234-2374 or Rick Banta, FTS 429-6367

UNITED STATES GOVERNMENT

memorandum

DATE: November 16, 1979

REPLY TO ATTN OF: Keith Bayha, CIFSG

SUBJECT: Written Materials re Instream Flow Methods

TO: Attendees of BLM Watershed Workshop, Elko, Nevada

Enclosed are copies of the materials I had intended to hand out in Elko.

1. The IFG Incremental Approach to Instream Flow Assessment (except from IFG 3-year report).
2. The IFG Incremental Methodology (except from CSU Critique Report now in press).
3. Status Report on Ongoing Instream Flow Studies (Note: This was last updated May 15, 1979. We expect to update again in January, therefore, if you have additions or corrections, we would like to hear from you in December).

These are only being sent to the 25 persons who requested the materials. If others in your office desire copies, it is permissible for you to duplicate them.

enclosures

KB/ad

Keith Bayha

RECEIVED
U.S. Department of the Interior
NOV 21 1979
Bureau of Land Management
Idaho State Office
Boise, Idaho

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

OPTIONAL FORM NO. 10
(REV. 7-76)
GSA FPMR (41 CFR) 101-11.6
5010-112

Exerpt from IFG 3-Year Report
now In Press

THE IFG INCREMENTAL APPROACH TO INSTREAM FLOW ASSESSMENT

The words incremental and incremetalism have a number of different connotations. First, incrementalism refers to an approach to problem solving. From an institutional standpoint, incrementalism refers to a policy of modifying political or social mores, decision-making procedures, and technical procedures, slightly from previously established procedures. This gives the decision-maker the advantage of familiarity with a "standard operating procedure ," yet allowing slight deviations from that procedure to accommodate perceived deficiencies in previous policy. A good example of this is the legal recognition of instream flows as a beneficial use of water. Rather than re-writing the water statutes, legislatures modified them slightly to accommodate a perceived deficiency in the law.

Instream flow issues often involve a large number of agencies and professions. These issues are often resolved through the efforts of lawyers, biologists, engineers, hydrologists, water managers, recreation planners, and water quality specialists. Each profession has a particular philosophical approach to problem solving. In fact, it is common for individuals of a given profession to gravitate toward agencies having problem solving philosophies consistent with their own. This tendency may become a source of conflict when two or more agencies become involved in a common issue. There may even be perceived differences of opinion as to whether or not a problem exists at all. One agency might view a particular water allocation plan as perfect, while another would view the same plan as a catastrophe.

Given the multi-agency and interdisciplinary nature of instream flow issues, it is important for individuals of each profession to understand the operational procedures and constraints of the other professions. The IFG has played a major role in this educational process through its workshops and short courses.

However, mere understanding of how one agency operates is usually insufficient cause for another agency to abrogate its own operating procedures or philosophies. One way to resolve this problem would be to develop a system for describing a status quo condition and then incrementally modify the driving variables to describe a new condition. This approach does not require any individual to radically alter his or her problem solving approach. It does require that two parties agree on what the status quo condition is. Once the starting conditions are defined, it is possible to incrementally change the system and reevaluate its condition. By reiterating the process with minor change, it is often possible to describe a condition satisfactory to both parties. It is quite possible that a solution arrived atincrementally would have been considered radical had it been proposed at the outset.

In this role the IFG has had the following objectives: (1) raising the level of awareness in the water resources administration community regarding the utility of instream uses of water; (2) raising the level of awareness in the water resources administration community and among environmental management agencies regarding the means currently available to protect instream uses; (3) to help those wishing to protect instream flows to deal more effectively within the legal and institutional arena. While it is difficult to determine the precise effect which the Instream Flow Groups activities have had in the water resources administration arena, it is clear that significant progress toward reaching each of these objectives has been made.

Through publications, training sessions, and technical assistance activities, personnel of the Instream Flow Group have reached an audience of water developers and water users not previosuly receptive to the idea of protecting flowing streams. Moreover, the Group has brought these persons into close interaction with persons wishing to protect stream flows, and has assisted in resolving conflicts among the groups. These efforts have culminated in a number of specific results.

Following the early lead of Oregon and Washington, the states of Colorado, Montana, and Idaho have taken affirmative steps to protect instream flows. Due to progressive developments in the water management community, protecting instream flow is now possible in several other states. In addition, some states such as North and South Dakota and Alaska have considered legislation concerning instream for protection. Each of these states have used the knowledge and experience at the Instream Flow Group in support of their instream flow protection activities. This support has ranged from consulting with the governor's subcabinet on natural resources in South Dakota, briefings for the western states water council, consultation with the northwest Colorado Council of Governments, 208 planners, technical support for instream flow applications in Idaho, and testimony before the governor's commission to review California's water rights law. IFG has also undertaken specific tasks in advising FWS and other operational personnel in support with their negotiation with the Corps engineers and Bureau of Reclamation regarding federal projects.

The result of these activities has been an increased awareness in the water resources administration community both of the need to protect stream flows and the means available to do so within the context of current law and administrative practice. Moreover, FWS and other operational personnel have become more competent and skillful in their attemps to protect instream flows. These new skills are frequently employed as a direct result of training or technical assistance received from the Instream Flow Group.

In the technical arena, the IFG Incremental Approach was designed with iterative problem solving in mind e.g., incrementalism. It provides the basis for describing a stream system in its present condition, and for modifying certain components slightly to ascertain the effects on the system. It also provides the framework for evaluating several options to achieve the same end result.

STUDY DESIGN - THE REPRESENTATIVE REACH CONCEPT

One of the initial hurdles to be cleared in the development of this approach was how to describe the system initially. This problem was rooted in the various perspectives taken in describing riverine ecosystems. One perspective is to examine a river from its headwaters to its mouth. Numerous authors have reported the addition or replacement of species as a function of stream order, stream size, gradient, or other descriptions of longitudinal gradations of environmental conditions (Shelford, 1911; Burton and Odum, 1945; Huet, 1959; Sheldon, 1968). This type of study relates the "longitudinal succession" of species as a function of such variables as mean depth, temperature, mean velocity, average substrate composition, or other environmental conditions which exhibit gradational change. Non-occurrence of species may be the result of different geographical distribution, or local preference.

The second perspective is to examine local preference in regard to the morphological, physiological, or behavioral adaptions made by various species. Hubbs (1941) noted that fishes from diverse groups have often made nearly the same physiological and morphological adaptations to certain well-defined environmental conditions. Many studies of this type have shown that the spatial and temporal selection of certain microhabitat conditions reduces interspecific competition. In fact, expansion into another species' preferred microhabitat in the absence of that species (competitive release) occurs less frequently than one would expect (Forbes, 1909; Everest and Chapman, 1972; Dettman, 1978; Alley and Li, 1978).

The geographic distribution of species in riverine systems is largely dictated by those longitudinal characteristics which define the macrohabitat. In essence, the characteristics of watershed and water quality establish the limits of distribution of a species. These bounds are often discontinuous, subject to inversions in the macrohabitat gradients.

If the macrohabitat conditions are sufficient for the growth and propagation of fish, the distribution and abundance of fish within the macrohabitat is a function of the availability of proper microhabitat conditions. A microhabitat might be perceived as a necessary subset of the macrohabitat. A macrohabitat might be adequate for fishes to exist in it, but without the necessary microhabitat, fish abundance will be limited. The converse is also true. Therefore, the quantification of habitats must concern both the longitudinal (macrohabitat) distribution of species and the three-dimensional (microhabitat) distribution of species within the macrohabitat. Gorman and Karr (1978) concluded that four variables were significant in determining the distribution and abundance of species in a river system. These are energy source (watershed inputs), water quality, channel structure, and flow regime. It can be argued that certain variables such as watershed and water quality change longitudinally through a system and could logically be defined as macrohabitat features. Channel structure and flow characteristics (hydraulic structure) together determine the microhabitat, but these too change longitudinally through the system.

The approach taken by the IFG is to superimpose detailed microhabitat characteristics onto more generally described, relatively homogeneous macrohabitats. Through this technique, boundaries of macrohabitat based on changes in watershed characteristics, water quality, overall channel geometry, or flow regime are delineated. Thus, a river system may be segmented into sections in which the macrohabitat conditions are relatively homogeneous. Macrohabitat gradations are illustrated by proceeding from one river segment to the next.

Within each of these large, relatively homogeneous segments, small reaches are randomly selected for detailed study of the relationship between microhabitat and streamflow. Such reaches are called representative reaches. Variations in microhabitat as determined by channel structure and streamflow are described over the length of macrohabitat represented by these sample reaches. This approach allows an investigator to describe not only the microhabitat conditions, but also how microhabitat grades with macrohabitat throughout the entire river system. Therefore, both the longitudinal succession perspective and the microhabitat selection perspective of riverine ecology are incorporated in the approach.

Starting with a predetermined water allocation perspective, the IFG approach to developing an analytical procedure sensitive to both macro- and micro-habitat quantification recognized that:

1. Physical processes drive biological processes, i.e. biological species evolve (respond) to fill niches in the physical habitat.

2. 4 components are interrelated as illustrated in Figure 3.

    a. watershed
    b. water quality
    c. channel structure
    d. flow regime

Consistent with a philosophy of incrementalism, it is necessary to first determine the characteristics of each of the components, determine the relationships among components, and be able to carry a change in one of the components through the entire system. It is this capability which allows the evaluation of the consequences of a small change anywhere in the system.

This approach starts with a hierarchical and modular setting. Figure 2 diagrams a structured thought process with a series of decision points, feedback loops, and cross-checking procedures needed to examine the components shown in Figure 1. The modules and various models available constitute the "building blocks" of this procedure.

A hierarchical approach is dictated by different levels of knowledge, simulation capability, and precision requirements for each of the modules. In terms of the degree of sophistication of analysis, the following levels of management application are defined:

Level 1 - Best professional judgment and use of simple calculations and nomographs, both within the system components and in linkages.

Level 2 - Mathematical models within each component are brought to bear. However, the linkage or information flow from one component to another rests with the judgment of the investigator.

Level 3 - Fairly sophisticated mathematical approaches are utilized and linkages among various components are structured in a system simulation manner.

Level 4 - The truly holistic approach to ecosystems and the frontier of knowledge concerning functional relationships among all contributing variables.

From the land and water management perspective, Level 3 would be the application of the state-of-the-art at its highest level of operational feasibility. However, most management decisions are presently made at Levels 1 and 2, and often with a mixture of Levels 1, 2, and 3 among various modules. It is the goal of the IFG to move components toward Level 3 sophistication, utilizing dynamic simulation techniques. This pursuit is taken in the spirit of incrementalism. If successful this approach results in a rapidly changing state-of-the-art. Experience of the IFG over the three years reported here, has shown such change to have indeed come about.

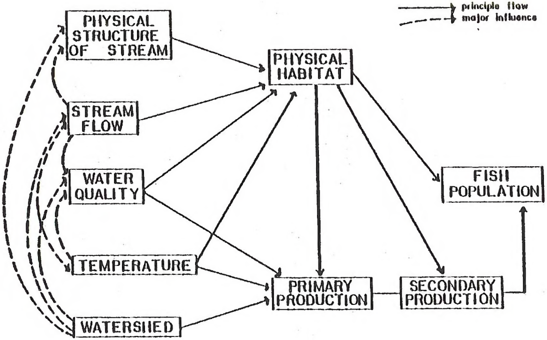

Figure 1. Major components and information flow for the analysis of fish populations of stream systems as a function of management alternatives.

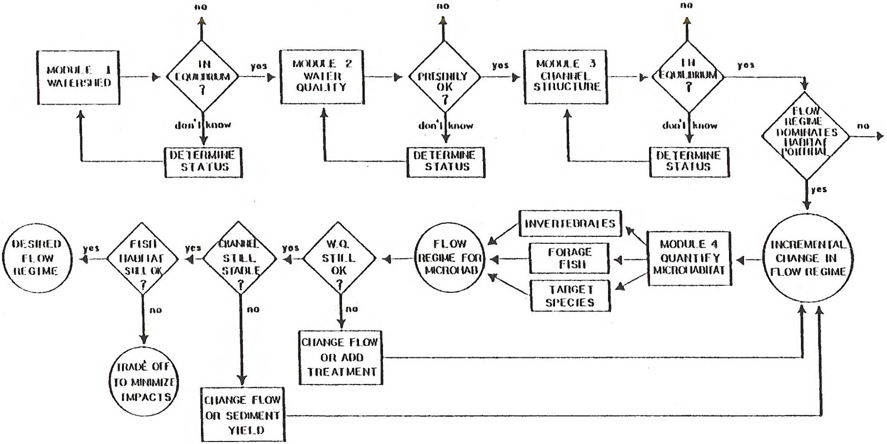

Fig. 2. A modular thought process showing decision points.

A rigorous critique involving about 50 nationally recognized authorities in the disciplines of river hydraulics, aquatic ecology, watershed and sediment routing, water quality and systems modeling was held at Colorado State University and cosponsored by OWRT midway through the 3-year period. Much of the character of the IFG incremental approach described in following sections of this report has come from this mid course evaluation.

MODULAR AND INCREMENTAL ANALYSES

The following is a description of the nature of the problems encountered in each of the modules, and the steps the IFG has taken to solve these problems.

Module 1 - Watershed

Location within the watershed is a controlling variable which determines the quantity and timing of runoff, dissolved and suspended chemicals, heat, and sediments which arrive at the stream. The nature of the watershed governs the delivery of water to the stream, which in turn governs the nature of the flow regime and the size and shape of the channel. The decomposition of parent materials and input of allochthonous organic material determines the nutrient input to the stream, and is influenced within the watershed by longitudinal changes in elevation, vegetation, geology, and climate. The substrate characteristics of a stream are dominated by the parent material present at various points along the longitudinal profile. Streams flowing through resistant igneous or metamorphic parent materials tend to be coarse bedded. Streams flowing through non-resistant, sedimentary parent materials tend to be fine-bedded.

It would be convenient if longitudinal changes in watershed characteristics proceeded in a regular manner. In fact, many watersheds do exhibit smooth gradations. Many others are typified by abrupt changes and occassionally by inversions. Consistent with the macrohabitat concept, the fauna of these streams reflect these abrupt changes.

Most riverine habitat evaluation techniques assume that the conditions of the watershed are held constant. This assumption is often made as a convenience; it is easier to assume the problem away than to attempt to predict changes to the system imparted by the watershed. Where land use changes are not anticipated, climatic and geologic factors can be safely assumed constants, and a steady state watershed is a safe assumption. However, a steady state assumption in an altered or to-be-altered watershed would be totally inappropriate.

In an undisturbed watershed, both the terrestrial and aquatic environments are in a dynamic equilibrium (Karr and Schlasser, 1978). Perturbations on the watershed such as timbering, agriculture, grazing, mining and urban development may drastically change the input rates to the aquatic system. Such watershed management activities affect the stream system in three major ways, a) through variations in water quantity input (either ground water or surface runoff) which affect the stream flow regime and in turn the physical structure of the channel, 2) through changes in heat, sediment, inorganic nutrients, and toxicants which all affect water quality and thus the physiological responses of the target organisms, and 3) through changes in the quantity of organic substances which influence the source of energy for utilization within the food web.

Watershed perturbations often take the form of modifications of the existing vegetation and exposure of non-resistant soil and parent material to erosion. This results in a more rapid runoff during storm events both of water and sediments. As the runoff becomes more instantaneous, less water is stored as ground water. This in turn affects the base flow, resulting in a "flashy" hydrograph, one which exhibits accentuated peaks and troughs during wet and dry periods, respectively.

A change in the yield of inorganic sediment affects the microhabitat in several ways. First, an imbalance in the sediment-discharge ratio may trigger a change in the shape of the stream. Secondly, the particle size distribution of the substrate is likely to change. Thirdly, the distribution of cover objects in and along the stream may be affected by submersion, bank erosion, encroachment, or physical removal.

Activities on the watershed may change the quantity and quality of the organic matter entering the stream. The quantities and proportions of large particulate organic matter (LPOM), fine particulate organic matter (FPOM) and dissolved organic matter (DOM), and inorganic nutrients, affect the types of primary food processors in the food web.

The input of large amounts of allochthonous (produced outside the aquatic system) organic matter is representative of a system with a low primary production/respiration (P/R) ratio and has a characteristic food web structure. A system relying predominantly on autochthonous organic matter would have a high P/R ratio and a significantly different assemblage of food web organisms. Any changes on the watershed which change the normal organic input to the stream system, may be expected to change the food web relationships of the stream, and possibly the sufficiency of the macrohabitat for specific fish species.

Approach. The initial question to be answered in this module is whether the watershed is in equilibrium with its drainage system, or whether it is changing. For a great many watersheds the question of watershed equilibrium can be answered with a simple yes or no, depending on the land use activities on the watershed. If the answer is yes, the user may proceed directly to the second module. If the answer is no, the investigator is faced with the problem of determining the direction and magnitude of the change. Although the IFG currently has no computer-based tools to make this determination, several avenues of analytical approach are available:

1. Monitoring watershed and associated habitat changes over a period of years to determine time trends.

2. Use of simple watershed models and equations to estimate water, sediment, and chemical yields.

3. Invest in an independent Level 3 modeling expert to build a sophisticated watershed model, or obtain the output of such models from other agencies.

4. Measure the stream characteristics in a similarly affected watershed, and scale those measurements up or down to fit the stream and watershed of interest.

Occasionally, a user will suspect watershed disequilibrium, but will not be able to say yes or no. If the user proceeds to the next module, it has been assumed that the watershed is in equilibrium. However, the stream system itself shows symptomatic warnings when in disequilibrium.

Warning signs indicating violation of this assumption include: 1) rapid runoff resulting in drastic high and low water levels of streams, 2) large amount of nutrients and sediments lost from the terrestrial to the aquatic component, often over short time periods, 3) increased fluctuations in stream temperature, 4) increased streambank erosion as the stream attempts to reestablish its equilibrium by forming a meandering, pool-and-riffle topography, and 5) decreased diversity and stability in the biotic component...as a result of the less stable environment (Karr and Schlosser, 1978).

If these warning signals are not present, or if for other reasons it is apparent that the assumption of watershed input stability could be made, then the IFG hydraulic computer software (IFG-2 or IFG-4 models) may be used to further evaluate habitat availability for selected target species at given flow rates. It must be stressed that the use of the IFG computer package, PHABSIM, (see discussion module 4) is dependent upon the assumption of watershed-riverine equilibrium. If this assumption cannot be made, or if a final equilibrium condition cannot be estimated, PHABSIM tool is not applicable and, the user must rely on other means to evaluate habitat suitability for specific target organisms. Dunne and Leopold (1978) provide an excellent discussion of watershed activity impacts upon stream environment.

Module 2-Water Quality

Water quality is a dominant macrohabitat feature which, on a large scale, determines the longitudinal distribution of fishes and invertebrates in a river system. Theoretically, the distribution of water quality characteristics should be perfectly graded through a river system. That is, the headwaters should start out with the lowest temperature, lowest dissolved solids, and highest dissolved oxygen. As the river descends through the watershed, the temperature should systematically increase, as should the total dissolved solids, both organic and inorganic. If all systems operated this way, and all dissolved solids were non-decaying, a simple dilution model would be all that would be required to relate flow regime to water quality.

Unfortunately, the real world is not so simple. Whereas longitudinal inversions are common in watersheds, they are the rule rather than the exception where water quality is concerned. Of the water quality parameters, temperature and inorganic dissolved solids are among the few which often follow normal longitudinal gradations. However, even temperature is subject to longitudinal inversions wherever an abnormal heat source is present.

Concentrations of non-conservative pollutants seem to be functions of nearly everything. Their initial concentrations are determined in the watershed, and subject to augmentation (point sources) and dilution as they move downstream. However, as they move, they react with each other and with oxygen in the water. The reaction rates are functions of temperature, oxygen concentration, and initial concentration of the pollutant. These in turn are affected by travel time, mix interval, and dilution which are functions of channel

geometry and flow regime. When addressing water quality, it is virtually impossible to exclude watershed and hydraulic features of the stream.

As in the case of an assumed steady state for the watershed, it is frequently "convenient" to ignore water quality or to assume that if sufficient flow is provided for fish habitat, maintenance of adequate water quality is guaranteed. For many streams, this assumption is usually valid. However, for many others, water quality is already a constraint on production, or will be under an altered flow regime designed to provide fish habitat. While some water allocation studies can legitimately ignore water quality, it will be the starting point for others. For some situations, consideration of water quality may enter the decision process at several points in the form of feedback loops (Figure 3).

Approach. The term "water quality" encompasses a wide variety of chemical and physical constituents of the water. In many cases, the potential effect of water quality may be determined by a simple screening procedure (Mar and Grenney, 1979). This procedure basically gives a "yes" or "no" answer to the question of the adequacy of water quality. Two components are required to solve the question: determination of constituent concentrations and evaluation of significance of those concentrations.

Information concerning the concentrations of various water quality constituents may often be obtained from published reports or records. U.S. Environmental Protection Agency (EPA) 303e and 208 studies, State Health Department Monitoring records, U.S. Geological Survey Surface Water Quality reports, and other sources contain this type of information. These records may be used to determine both spatial and flow-related changes in water quality. With no anticipated changes in source loading, such an empirical data base may be used directly to determine concentrations of various constituents at different streamflows.

In many cases, such information is not available, and in others, changes in streamflow may be accompanied by changes in source loadings. In these cases, some type of water quality model will be required to predict constituent concentrations.

The IFG has adapted the Stream Simulation and Analysis Model (SSAM), developed at Utah State University by Grenney et al. (1974). This model is described in the section on Research and Development. SSAM may be used at either Level 2 or Level 3, depending on the degree of resolution desired. An operational version will be available as soon as program documentation is completed.

The SSAM model is designed for steady flow situations. A second model, WQRRS, developed by the U.S. Army Corps of Engineers, is designed for unsteady flow situations. The IFG has recently acquired this model to accommodate problems not addressed by SSAM.

While the state-of-the-art in water quality modeling has achieved a high degree of sophistication, the same cannot be said regarding the development of water quality evaluation criteria. For the most part, these criteria have been developed through the use of laboratory bioassays. This type of controlled testing may or may not have relevance to animals in nature, subjected to a variety of simultaneous stresses. Should water quality

constituent concentrations fall outside the established criteria, one can be relatively certain that water quality will be a problem. However, water quality constituent concentrations falling within the criteria bounds do not necessarily mean that no problem exists. A more complete discussion of evaluation criteria is presented in the section on research needs.

Module 3-Channel Structure

Channel structure refers to features of the channel which provide resting and feeding areas for fish and food organisms. These features include channel morphology and alignment, substrate size and distribution, and cover characteristics.

The size and shape of a channel is a function of the geology of the area through which the stream flows, and of the flood flows carried by the stream. The alignment is often a function of the watershed characteristics, but is frequently altered by man's activity within the channel. Substrate size within the channel is dominated by the sediment yield from the watershed. The distribution of various substrate sizes in the stream is a function of both the yield and channel hydraulics.

Channel structure may affect the biological community directly, through changes in sediment and cover characteristics. Indirect affects, primarily due to changes in size, shape, or alignment, are caused by re-distribution of depths and velocities through the reach.

The contribution (yield) of water and sediment from the watershed to the stream system, in addition to providing the energy source (coarse particulate organic matter) and influencing the chemical quality, sets up a dynamic equilibrium with the stream channel structure. Disturbances upon the watershed often upset this equilibrium, resulting in a dramatic shift in channel form and sediment transport to compensate and move toward a new equilibrium state. Frequently, such a disturbance will cause changes in all three aspects of channel structure. However, it is possible for a stream to retain its present shape, yet experience changes in sediment size.

Conversely, in many channel realignment (channelization) cases, the substrate size remains approximately constant, but the shape and alignment of the stream is radically altered.

Modification of the flow regime, with or without a watershed disturbance, may also upset the sediment-water equilibrium with similar results. A frequent mistake in instream flow studies is to determine a flow regime which is satisfactory from a microhabitat standpoint, without checking to make sure the flow regime is sufficient to maintain the channel in its present form. Thus, a stability of microhabitat by guaranteeing a flow regime may impose an instability in the same microhabitat by modifying the channel structure.

Approach. The determination of equilibrium status for channel structure may often be accomplished by a screening process similar to the one used under water quality. Perhaps the easiest technique is to obtain U.S.G.S. rating curves for a five to ten year period, for gaging stations along the stream. An analysis of these rating curves can indicate equilibrium if the same rating has been used for a long time. Persistent changes due to aggradation or degradation of the bed are also apparent in the ratings.

of overlay maps, delineating areas where the depth, velocity, and substrate are within the preferred ranges for spawning salmon. Areas of intersection of all three preferred ranges are identified and measured by planimeter. This procedure is repeated for a range of discharges, and a plot of discharge versus preferred spawning area is developed. USGS, Tacoma, Washington, has developed a computer program (DVA TRAPESIARRAY) used in producing these plots for the Washington Departments of Fisheries and Game. Although time consuming, the method is straightforward and fairly simple in design (necessary attributes for presentation to water administrators). Since input is empirical field data, and output is graphical in nature, the results of the method were easily understood.

The method of Collins, et al., utilizes as decision criteria the range of depths, velocities, and substrates utilized by salmon for spawning. These ranges are termed "binary" criteria, where the utility of a variable takes on the integer value of zero or one, depending on whether or not it falls within the preferred range of the animal.

In 1976, B. F. Waters presented a methodology which was an outgrowth of work initiated by the California Department of Fish and Game (Waters, 1976). The basic concept is the same as described by Collins et al. (1968), except that Waters substituted for binary criteria, weighting factors which ranged from zero to one, to represent the relative habitat values of the three stream attributes. The relative habitat values for each stream attribute were multiplied together to obtain a single composite value for a combination of attributes. This composite value was then multiplied by the area of stream having that combination of attributes to obtain an equivalent "optimum quality streambed area." Waters observed that these weighting factors could be varied as a function of species, life stage, or principal food organisms. He further observed that these weighting factors could be estimated for many species from information available in the literature and from professional judment; but for some species, this information could be obtained only from new research.

The principle drawback to the methodologies as applied by Collins, et al. (1968) and Waters (1976) and others (Stalnaker and Arnette, 1976) was that they were very labor intensive in the acquisition of hydraulic parameter information from the stream. During 1976, several researchers (Cochnauer, 1976; Dooley, 1976; Elser, 1976; Workman, 1976; White, 1976) began investigating the use of hydraulic modeling techniques to simulate hydraulic conditions at different discharges, with minimal time involvement in the field.

However, in 1976, the use of hydraulic simulation modeling for habitat analysis was in its infancy. The hydraulic models available could best be described as macrohabitat models, giving output in terms of mean depth and mean velocity at a cross section. As such, the models were not precise enough for the in-depth microhabitat quantification suggested by Collins, et al. (1968) and Waters (1976).

The first task undertaken by the IFG was the modification of both the conceptual view of the stream reach used by Collins and Waters, and the hydraulic simulation models available. Rather than viewing the stream reach as a series of depth, velocity, and substrate contours, the stream reach was viewed as a series of small cells. The length of a cell is the distance halfway upstream and downstream from a transect to adjacent transects. Each

transect is subdivided into a number of subsections, the width of each being translated as the width of the cell.

The hydraulic models were then upgraded, so that instead of one average depth and velocity for the cross section, the depths and velocities of all the cells could be predicted. This goal was accomplished by improvements made to the single transect (IFG-1) and the multiple transect Water Surface Profile Program (IFG-2). A third multiple transect model (IFG-4) was developed for use in rapidly varied flow situations.

The stream reach simulation takes the form of a multi-dimensional matrix corresponding to the stream cells, of the calculated surface areas of a stream having different combinations of hydraulic parameters (i.e., depth, velocity, substrate, and cover when applicable). This is the total summation of surface areas within the stream reach with a given combination of hydraulic and structural attributes.

The significance of the hydraulic and channel structure features in each cell is then evaluated following the procedure suggested by Waters (1976). Univariate curves showing the relative suitability of various stream attributes by life stage and species were developed by IFG (Bovee and Cochnauer, 1977). From these curves, a weighting factor for the depth, velocity, and substrate in each cell is determined. These weighting factors are multiplied together to estimate the habitat suitability for that combination of variables, and this joint index is multiplied by the surface area of the cell. The product of the joint habitat suitability index and the cell surface area is termed the "weighted usable area" for the cell. This process is repeated for each cell, with the weighted usable areas for all the cells summed to give the total weighted usable area for the reach.

By changing the flow, the distribution of depths and velocities, in association with various substrate types and cover objects, changes. As the flow changes, the habitat value of each cell changes, and this is reflected in the total weighted usable area. Often, these changes balance out. That is, some cells decline in their usability while others increase theirs. Therefore, it is often possible to identify several discharges which provide the same measure of habitat suitability.

Mathematical implications of this computation procedure are discussed in detail in the section on research and development.

The general relationship between this habitat suitability index (WUA) and the carrying capacity for the appropriate species is hypothesized to be approximately linear with a positive slope. The validity of this assumption remains after several field tests and is discussed in Section VI, Research and Development. Provided that this relationship remains valid, the fishery manager may one day be in a position to answer the final question, "How many fish are gained or lost?"

While PHABSIM represents the synthesis and use of techniques which already existed, the examination of incremental changes in flow and habitat is a new application of the technique.

Water resource mangement utilizes water supply information based upon annual variation (annual hydrograph) and historical records (often displayed as monthly flows with certain recurrence intervals). The distribution of the hydraulic parameters of depth and velocity through a stream reach is a deterministic function of the flows (discharges) present and can be described as a stochastic process utilizing existing hydraulic simulation techniques. The theory and application of these approaches to instream flow studies are discussed by Bovee and Milhous (1978).

A traditional approach in most controlled river systems has been to establish a "minimum" flow for certain stream reaches. The system is then operated with this minimum flow as a constraint which is often violated under certain conditions such as low water yield (drought). Rarely are river system operating criteria developed with any consideration of the stochastic variation of the water supply and the subsequent variable nature of the production of benefits from use of the water instream (Bovee and Milhous, 1978). Most fishery/flow studies to date have failed to address the stochastic variation in the hydraulic features of the instream habitat.

The usual approach is to plot the mean values of the hydraulic parameters of depth, velocity, wetted perimeter, surface width, etc., or a habitat index incorporating several of these parameters, against a scaled discharge range for the channel cross sections of interest (Figure 3). The "minimum" desirable flow is then interpolated from the peak or inflection point of the curve. This does not take into account the timing or frequency of such events and implies that constant flow (flat hyrograph) is the objective of management.

Recent studies of fish habitat and channel maintenance flow requirements have shown that both are a function of the dynamic flow patterns of the stream hydrograph within a given year and most dramatically amoung years (Figure 4). Thus the flow requirements for maintaining any desired level of stream channel fish and habitat structure must be dynamic and can only be protected by establishing instream flow regimes for wet years (sediment and bed load transport); average years (establishes the base level of fish production); and dry years (provides minimal survival conditions for "seed" stock necessary for replenishing the stream reach).

Flow requirements may differ among fish species and life stages as well as other instream uses, thus forcing the management agency and the public to define the management objectives for the stream reach in question.

DISCUSSION

The Incremental Method is a structured procedure providing a series of decision points and feedback loops, connecting the major habitat components elaborated by Gorman and Karr (1978). The method itself is incremental because it is possible to start with some set of initial conditions, vary conditions slightly in any module, and determine the impact of the fluctuation. More specifically, the method is designed for iterative use.

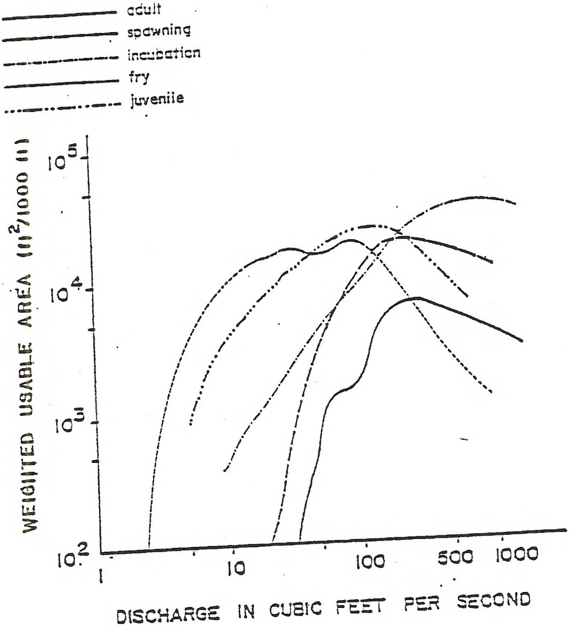

Figure 3. Habitat-discharge relationship for five life stages of steelhead in a coastal California stream.

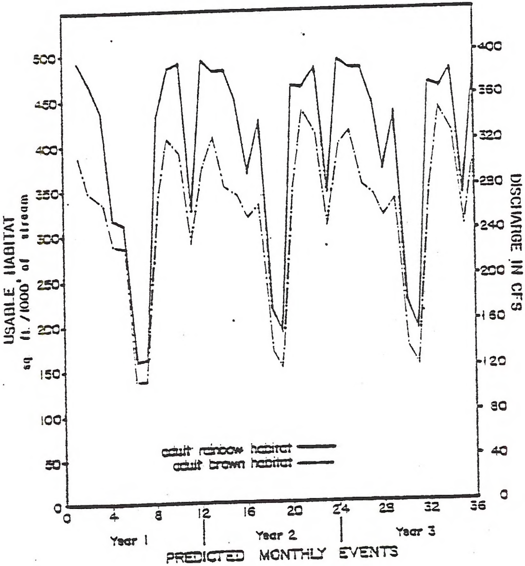

Figure 4. Variation of usable habitat for adult rainbow and brown trout over a three year period.

For example, initial conditions might be defined as follows:

1. Watershed unaltered and stable
2. Water Quality marginal but within bounds of criteria
3. Channel structure in equilibrium, primarily cobble bed with extensive deposits of 10-25 mm gravel.

Given this set of initial conditions one might proceed directly to calculations utilizing PHABSIM, and determine habitat conditions for a median (1-in-2 year) flow regime. By tinkering with the input discharges, it might be possible to determine a flow regime which requires less instream flow than the median flow regime, yet provides sufficient instream habitat.

However, if by re-running these discharges through the water quality model, it is determined that this flow regime will result in dissolved oxygen concentrations during July and August which are too low, two solutions could be explored:

1. Incrementally increase the flow until the DO concentrations re-attain satisfactory levels, or;
2. Incrementally increase the level of treatment to lower the BOD concentration in the river. Various combinations of streamflow and level of treatment could also be investigated.

Further investigation shows that the flow levels providing good fish habitat during February and in June, would allow deposition of sand sized material over the gravel bars during the two peak sediment production months. Replacement of gravel with sand substrate in PHABSIM shows that while little effect on fish habitat usability occurs, spawning and insect production will be radically curtailed. Therefore, it is determined that prevention of this sedimentation is desirable.

The flow during these two months is then increased until a flow level is found which is just sufficient to prevent the deposition of sand on the gravel bars. However, on running these flows through PHABSIM, it is found that the flows required for sediment transport are detrimental to newly hatched fry. As the flows are increased beyond the threshold level for transport of sand, backwaters along the stream margin are flooded, providing the microhabitat required by the young fish. By continued iteration, it is possible to determine the flow regime which provides both fish habitat and sediment transport capability.

Not all scenarios will work out this nicely. In some instances it will not be possible to find a flow which will accomodate several uses at once. In these cases, some form of trade-off decision, or alternative management plan will need to be formulated. In the previous example, suppose that flows required to move sediment were totally incompatible with the flows required by young fish. One management alternative might be to build sediment traps along the river to prevent the sand from reaching the stream. This technique might trigger undesirable side effects, such as degrading the bed, so it would have to be checked out. Another alternative would be to wait until after the

passage of the sediment transporting flow, and then to stock fingerlings of the desired species. A third alternative might be to allow a high flow once every three or four years to remove accumulated sediment, with full knowledge that that year's recruits are sacrificed. Regardless of the alternative selected, the Incremental Method could be employed to evaluate its effects on the system.

Exerpt from CSU Critique Report
now In Press

THE IFG INCREMENTAL METHODOLOGY

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Introduction

Instream flow requirements, often called instream flow needs, are the amounts of stream flow necessary to sustain instream values at an acceptable level. By instream values we mean the uses made of water within the stream channel. These include such traditional uses as navigation, hydropower generation, and waste load assimilation (water quality). In addition to these more established uses, fish and wildlife needs; riverine based recreation; compact and treaty requirements at downstream points of diversion; fresh water recruitment to estuaries, and consumptive requirements of riparian vegetation and floodplain wetlands are emerging as potent competitors for stream flows.

In addition to satisfying delivery schedules of downstream appropriators (water right holders), an ideal stream flow management plan should provide an "additive flow requirement" and a "complimentary instream flow requirement." Hence the total stream flow requirement for a given stream reach at a particular time is the sum of (1) the delivery requirement to satisfy downstream water rights, (2) an additive flow requirement to offset consumptive uses enroute, and (3) the complimentary instream flow requirement (Fig. 1).

The most desirable total stream flow requirement is one that will satisfy several uses at once. Understandably, at a given location on a given stream, only certain uses may be relevant, or preferential consideration may be given to the use(s) regarded as most important. But in either event stream flow is apportioned through negotiation and compromise. A paramount concern in these deliberations is the ability to analyze the acceptability of incremental changes in stream flow with respect to a particular use.

Instream flow assessments have traditionally arrived at a single threshold value for the fishery resource - "a minimum flow." Such an instream flow recommendation was usually determined solely from an analysis of hydrologic records, and provided only a limited opportunity for negotiation. This approach is based on the mistaken assumption that only flows below this "minimum" will be detrimental to the fishery resource. As a result of the fallacies and weaknesses associated with traditional fishery assessments it was apparent that better methods were required.

The IFG incremental methodology is a major advance in this regard for it attempts to quantify the amount of potential habitat available for each life history stage of a species as a function of stream flow. This method is intended to be used as a decision-making tool and is specifically tailored to demonstrate the impact of incremental changes in stream flow on fishery habitat potential.

The Incremental Methodology is intended to be used in those instances where the flow regime is the dominant determinant of the quality of the

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[1] On assignment from University of Idaho, Moscow, Idaho, 1978-1979 under Intergovernmental Personnel Act Agreement.

instream fishery or recreation resource and where hydraulic conditions are compatible with the theoretical basis of the models (i.e. steady flow within a rigid boundary). This method is composed of four basic components: (1) field measurement of stream channel characteristics using a multiple transect approach; (2) hydraulic simulation to determine the spacial distribution of combinations of depths and velocities with respect to substrate and cover objects under alternative flow regimes; (3) application of habitat suitability criteria to determine weighting factors; and (4) calculation of weighted usable area (gross habitat index) for the simulated stream flows based on physical characteristics of the stream.

Four primary variables can be identified which determine the character of instream habitat conditions: (1) water chemistry; (2) food web relations; (3) flow regime; and (4) channel structure. Associated with each of these major variables are the respective subsets of variables which interact to provide the myriad of physical-chemical conditions to which the stream biota respond. These four primary variables also offer a logical division for approaching the task of quantifying the effects of land and water management decisions on instream fishery resources.

During the 18 months preceding this workshop the Instream Flow Group's efforts concentrated on describing cause-effect relationships between stream flow alterations and instream fishery habitat potential. In western streams the most direct relationships (habitat constraints) are attributable to flow regime and/or channel structure. Consequently, hydraulic simulation modeling is of central importance to the incremental methodology.

Study Site Selection

Time and financial resources are seldom adequate to support the field work necessary to document stream flow-habitat relationships throughout an entire stream. Therefore, it is important to select study sites which are both characteristic of the stream, and capable of providing pertinent information. Either of two approaches to study-site selection can be utilized with the incremental methodology; (1) critical reach, and (2) representative reach.

Under the critical reach concept the study site is selected on the basis of its restrictiveness, i.e., stream flow characteristics at the critical reach are limiting attainment of the full potential of the instream resource. Associated with the critical reach concept is acceptance of the assumption that adequate stream flow through the critical reach will provide for satisfactory stream flow conditions throughout the remainder of the stream.

The critical reach concept implies that rather extensive knowledge of both the stream (hydrology, water-quality, channel geometry) and the instream resource (species composition, life history, passage requirements) exists. One must be satisfied that conditions at the selected study site(s) are, in actuality, limiting the instream resources potential. It should also be recognized that critical reaches only provide information specific to a particular set of questions; thus little opportunity would exist to utilize the critical reach data base to address questions pertaining to other instream uses.

A fisheries manager might select a critical reach on the basis of migration blockages, overwintering areas, or essential spawning and rearing habitat. In the case of endangered species, critical reaches might be selected on the basis of a unique combination of microhabitat conditions which are quite unrepresentative of the general riverine habitat type. With regard to instream recreation potential, a critical reach might be chosen on the

observed at selective stream flow conditions. The IFG's simulation models normally use stream channel geometry and velocity data from several cross sections within a relatively short stream reach. Each transect can be subdivided into as many as 100 cells (conveyance areas) to facilitate detailed analysis of the spacial distribution of depth and velocity combinations. Once properly calibrated, the computer program will calculate the water surface evaluation and respective horizontal velocity distribution at each transect for all desired discharges. The simulated water service elevations and velocities are then passed from the hydraulic model to IFG's HABTAT model (Main 1978a).

Within the HABTAT model, the mean depth of each cell is computed by subtracting stream bed elevations from the simulated water surface elevation. Surface areas associated with the occurrence of various combinations of depth/velocity values are calculated by multiplying the width of the cell by the sum of half the reach distance to the next upstream and the next downstream transects. This procedure is illustrated in Figure 2.

The stream reach simulation takes the form of a multi-dimensional matrix showing the surface area of cells having various combinations of physical habitat characteristics (i.e., depth, velocity, substrate, and cover when applicable). Table 1 illustrates a depth-velocity matrix. The number in the upper lefthand corner of the matrix refers to 195 square feet of surface area per 500 feet of stream length having a combination of depths less than 1.0 feet and velocities less than 0.5 ft./sec. This represents the summation of the surface areas of all the individual cells within the simulated reach with that combination of depth and velocity. This 195 square feet of surface area is not necessarily contiguous.

These criteria[2] were prepared by life history stage for those streamflow parameters directly influenced by changes in flow regime or channel geometry and which were considered to most directly affect fish distribution; depth, velocity, substrate and temperature. Species criteria for the Salmonid fishes were developed and distributed by the Instream Flow Group in 1978 (Bovee 1978).

The habitat suitability curves used in conjunction with the IFG methodology are based on the understanding that individuals of a species tend to select the most favorable conditions available within a stream for habitation, but will use less favorable conditions with less frequency eventually leaving an area if possible before conditions become lethal. Subsequently individuals would be most frequently observed (sampled) in nature inhabiting their most preferred habitat conditions. Implicit in the use of these criteria is the assumption that frequency of observation is, in fact, indicative of habitat preference and the understanding that the data base used to construct the curves was obtained in an unbiased manner.

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[2] Editors note: Prior to the workshop being reported on in this proceedings these species criteria curves were referred to as probability-of-use curves. However, it became apparent during the course of the workshop discussions that these curves needed to be renamed. Several names have been considered but the one chosen for use is "Habitat Parameter Suitability" curves.

Table 1. Occurrance of different combinations of depth and velocity, expressed in square feet of surface area per 500 feet of stream reach. Discharge = 800 cfs.

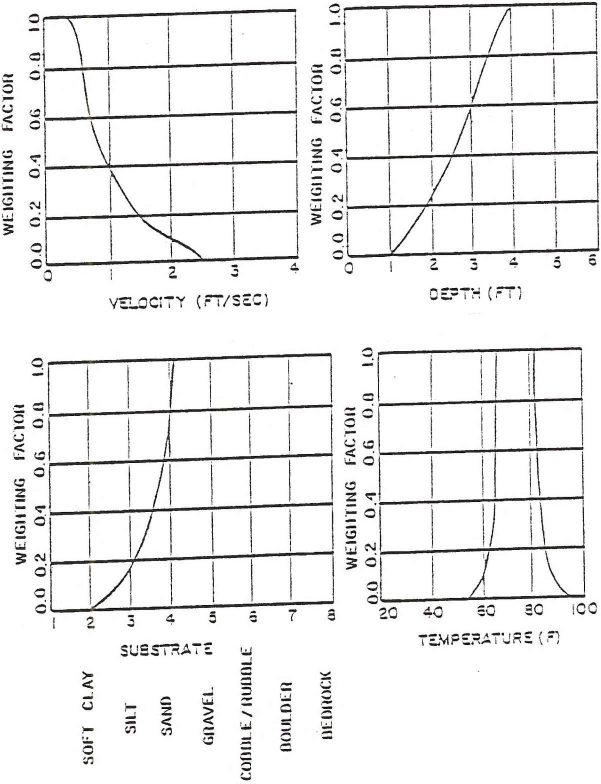
Depth (ft.)	VELOCITY IN FEET PER SECOND								Row Totals
	.5	.5-.99	1.0-1.49	1.50-1.99	2.0-2.49	2.5-2.99	3.0-3.49	3.5	
1	195	26	--	--	--	--	--	--	221
1.0-1.5	90	47	--	41	17	6	6	93	300
1.5-2.0	29	38	32	44	108	79	38	172	540
2.0-2.5	6	29	23	9	111	131	143	175	627
2.5-3.0	6	15	55	79	41	64	41	105	406
3.0-3.5	9	17	15	12	32	3	149	--	237
3.5-4.0	9	20	--	17	47	17	82	--	192
4.0-4.5	--	20	--	11	50	35	17	--	133
4.5-5.0	--	11	--	5	115	20	--	--	151
5.0-5.5	--	--	--	7	23	15	--	--	45
5.5-6.0	--	10	--	--	31	20	--	--	61
Column Totals	344	233	125	225	575	390	476	545	2913

In order to translate changes in stream hydraulics into impacts or effects on fish habitat it is necessary to identify describable relationships between appropriate hydraulic parameters and the target species or target group of species. Assemblege of such an information base was undertaken in 1977 by the IFG staff utilizing existing data from the scientific literature and files of state fishery management agencies. Four techniques were used to develop a preliminary information base in the form of two dimensional curves (originally called probability-of-use curves and as suggested during the workshop now called habitat suitability curves) describing species preference for a particular stream flow parameter. (Bovee and Cochnauer 1977).

Figure 3. Habitat Suitability Curves for

Adult Smallmouth Bass

(clear water)



Weighting factors (ref. Fig. 3) for the depth and velocity ranges used in the matrix are enclosed in brackets. The upper numerals in the matrix refer to the surface area of the stream per 500 feet of reach which possesses that combination of depth and velocity (ref. Table 1), while the numerals in parenthesis refer to the equivalency in weighted usable area ($WUA_i = C_iA_i$). Note that in this example the total surface area per 500 feet of reach (2913 ft^2), has been equated to 381 ft^2 of surface area possessing most suitable depth-velocity conditions.

Using the IFG's hydraulic simulation models, one can readily generate velocity depth matricies for unobserved streamflow rates passing through the study site. With these new velocity-depth values at hand, the compilation procedure is repeated to obtain weighted usable area values for the streamflows being simulated. As a result, weighted usable area can be displayed as a function of streamflow for each life history stage of the target species (Fig. 4).

Given the necessary streamflow records, weighted usable area may be presented as a function of mean monthly flow rates. Such a display facilitates comparison of changes in habitat potential between average and drought year conditions (Fig. 5), or demonstrating impacts of streamflow withdrawal (diversion) on a selected life history phase (Fig. 6).

For purposes of project planning, one may find it desirable to compare weighted usable area fluctuations under pre and post project conditions. Figure 7 presents such a time series comparison of anticipated trends and fluctuations in weighted usable area. In this example, weighted usable area values attributable to September streamflow conditions are compared. However, weighted usable area values for any critical period could serve as a basis for such a comparison.

In summary, the IFG Incremental Methodology was developed as a decision-making tool for use in the water allocation arena. It links various elements of fisheries behavior science and open channel hydraulics in an attempt to describe the effects of incremental changes in streamflow on the instream fishery potential. The methodology may also be used to identify effects of stream channel alterations on fish habitat conditions or to predict possible shifts in species composition as a result of flow or channel changes.

The methodology is intended for use in those situations where the flow regime is the major determinant controlling the fishery resource and field conditions are compatible with the under-pinning theories and assumptions of the methodology: 1) steady state flow conditions exist within a rigid channel and, 2) individuals of a species respond directly to available hydraulic conditions. If these assumptions can reasonably be made, the methodology has application to three basic types of questions.

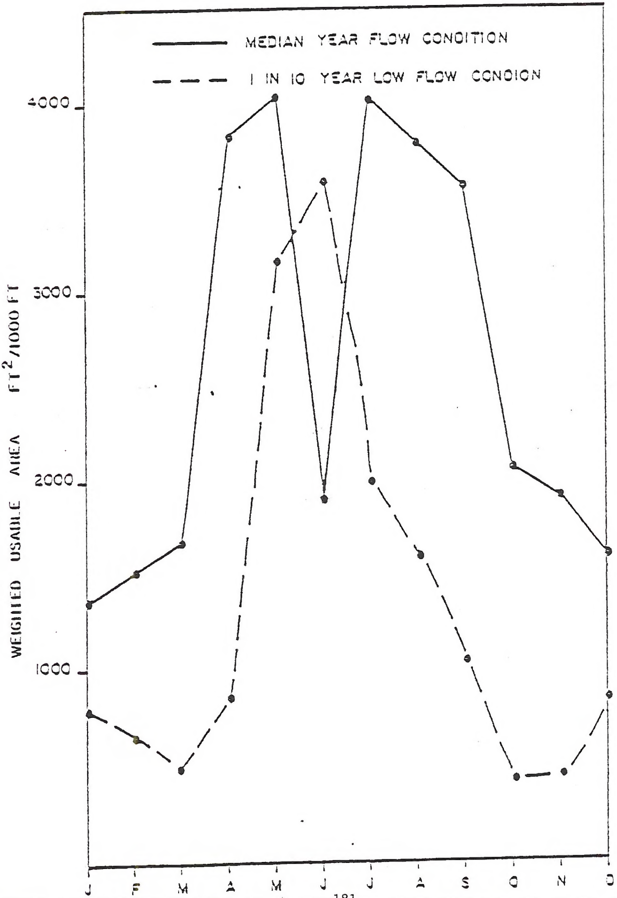
1) Quantification of Instream Flow Requirements

    a) Area wide planning
    b) Reservation or licensing of water rights

2) Negotiation of Water Delivery Schedules

    a) Minimum releases
    b) Yearly flow regimes (normal vs dry year conditions)

Figure 5. Monthly Weighted Usable Area Values for Adult Smallmouth Bass under Median and Drought year flow conditions



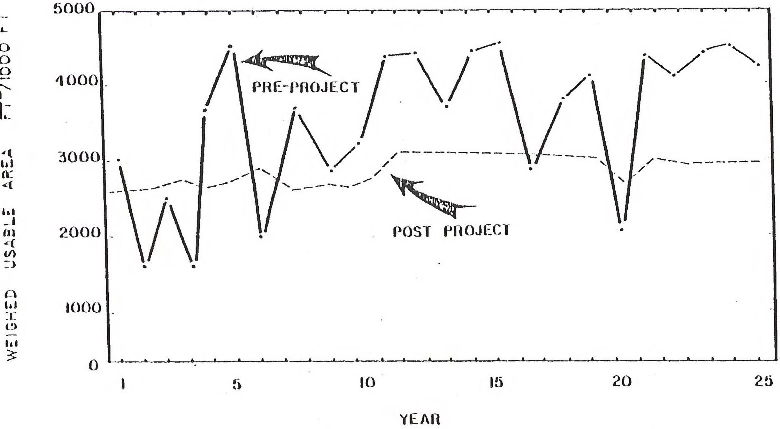


Figure 7. Comparison of Weighted Usable Area for Adult Smallmouth Bass during September at study site xxx projected for pre and post project conditions.

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UNITED STATES GOVERNMENT

memorandum

DATE: August 15, 1979

File: IFG 1300

REPLY TO ATTN OF: Cooperative Instream Flow Service Group

SUBJECT: Status Report of Ongoing Instream Flow Studies

TO: Principal Investigators of Instream Flow Studies
Ecological Services Field Supervisor
Regional Team Leader

The Instream Flow Group has prepared the attached initial status report of ongoing instream flow studies. During the coming year we expect to enter an agreement with USGS to provide the primary data source for their National Water Use Data System (NWUDS) with respect to instream flow studies. To help us update our existing information (see attachment) and to get a jump on pulling together data for NWUDS, we would appreciate your filling out the attached form (last sheet of attachment) for those streams where you know work is under way or anticipated during the coming year. We suggest you photocopy the blank form before entering data to assure a sufficient supply of forms. Do not worry about duplicating other possible reporters. We will cope with such events at this end. We would rather get two or more reports rather than miss the study entirely.

We would also appreciate receiving copies of plans-of-study and completed reports (either published or unpublished).

Clair Stalnaker
Clair B. Stalnaker
Leader

enclosure

KB/sh

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

OPTIONAL FORM NO. 10
(REV. 7-76)
GSA FPMR (41 CFR) 101-11.6
5010-112

DRAFT

STATUS REPORT OF APPLICATION OF PHABSIM

(IFG INCREMENTAL METHOD)

FOR DETERMINING INSTREAM FLOW REQUIREMENTS

- June 1979 -

Cooperative Instream Flow Service Group
Office of Biological Services
US Fish and Wildlife Service
2625 Redwing Road
Fort Collins, Colorado 80526
(303)223-4275

DRAFT

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IN~~S~~TRODUCTION

This is the first in what is anticipated to be a series of reports detailing the breadth of geographic and agency application of the Instream Flow Group's (IFG) computerized Physical Habitat Simulation System (PHABSIM). The purpose is to inform present and potential users of the ongoing activities related to quantification of instream flow requirements. This first report also reviews the development of PHABSIM for those who may not be familiar with the past efforts of many investigators which established the solid foundation upon which the IFG has built this state-of-the-art methodology.

Following computerization of this kind of data, expected to begin in October 1979 under funding support from US Geological Survey's (USGS) National Water Use Data System, this type of report can be produced on demand as the need arises.

EVOLUTION OF PHABSIM

Many studies have documented the importance of the physical parameters of temperature, depth, velocity, and substrate in the microhabitat specialization of stream fishes (Giger, 1973; Hooper, 1973; Bovee, 1974; Gorman and Karr, 1978; Paragamian, 1978). A parity of hydraulic studies have likewise documented that these variables exhibit the largest degree

of change with discharge (Curtis, 1959; Leopold, et. al., 1964; Kraft, 1972; Hooper, 1973; Bovee, et. al., 1977).

Under conditions of suitable habitat structure and temperature, the distributions of depth and velocity are the dominant aspects of flow which dictate fish distribution and territorial behavior (Gorman and Karr, 1978; Matthews and Hill, 1979). In marginal habitats, temperature may interact with these variables to determine distribution and abundance of stream fishes (Dettmen, 1978).

In 1976, the IFG was established and undertook the development of a comprehensive methodology to solve the types of complex problems encountered by US Fish and Wildlife Service (USFWS) field offices and their state counterparts. The approach taken by the IFG has been to develop tools in module form, linking each module by an interface program or logic. This enabled the group to assemble an operational program within a short time-frame, thereby providing user groups with much needed habitat analysis tools without a prolonged development period. It also enabled the IFG to improve and update individual modules as the technology became firmer, without unduly upsetting current users. To date, the IFG has developed a sophisticated system of complex deterministic and statistical models, complete with interfacing software, and interpretive techniques. This large system has collectively been called the "IFG incremental method." An integral subset which has been tested and is now an operational component of the incremental method is the PHABSIM.

PHABSIM

PHABSIM represents the synthesis of ideas and applied methods from a long history of instream flow research and applications (Orsborn and Allman, 1976; Stalnaker and Arnette, 1976). The structure of the PHABSIM model is derived from a method developed by fishery scientists in the Pacific Northwest as described by Collings, Smith, and Higgins (~~1968~~ 1972). This approach uses a series of overlay maps, delineating areas where the depth, velocity, and substrate are within the preferred ranges for spawning salmon. Areas of intersection of all three preferred ranges are identified and measured by planimeter. This procedure is repeated for a range of discharges, and a plot of discharge versus preferred spawning area is developed. USGS, Tacoma, Washington, has a computer program (DVA TRAPESIARRAY) which are used to produce these plots for the Washington Department of Fisheries and Game. Although time consuming, the method is straightforward and fairly simple in design (necessary attributes for water administration technology presentation). Since input is empirical field data, and output is graphical in nature, the results of the method are seldom arguable.

The method designed by Collings, et. al., utilizes as decision criteria the range of depths, velocities, and substrates utilized by salmon for spawning. These ranges are termed "binary" criteria, where the utility of a variable can take on only the integer values of zero or one, depending on whether or not it falls within the preferred range of the animal.

A great deal of effort has been expended in the Pacific Northwest and Rocky Mountain Regions to determine the preferred ranges of depth, velocity, and substrate for various salmonids (Smith, 1973; Hunter, 1973; Sams and Pearson, 1963; Wesche, 1974).

Bovee (1974) and White (1976) suggested that the same technique could be applied in warm water streams, utilizing "binary" criteria developed specifically for warm water species. Subsequently, the method was applied and field tested in the Tongue River, Montana, with satisfactory results (Bovee, et. al., 1977).

The use of binary criteria has a few drawbacks, however, not the least of which is a lack of standardization of the limits of the ranges used as criteria. Smith (1973) suggested that the preferred range of a particular variable for a species should include 80% of the observed individuals, with 10% of the observations above and 10% below the cut-off points for the criteria. Other authors suggested use of the total range of a variable ever used by a species. Bovee, et. al. (1977) suggested the use of cluster analysis with a bivariate (depth and velocity) distribution.

In 1976, B. F. Waters presented a methodology which was an outgrowth of work initiated by the California Department of Fish and Game (Waters, 1976). The basic concept is the same as described by Collings, et. al. 1972 (~~1968~~), except that Waters substituted for binary criteria weighting

factors, which ranged from zero to one, to represent the relative habitat values of the three stream attributes. The relative habitat values for each stream attribute were multiplied together to obtain a single composite value for a combination of attributes. This composite value was then multiplied by the area of stream having that combination of attributes to obtain an equivalent "optimum quality streambed area." Waters observed that these weighting factors could be varied as a function of species, life stage, or principal food organisms. He further observed that these weighting factors could be estimated for many species from information available in the literature and from professional judgement; but for some species, this information could be obtained only from new research.

The principle drawback to the methodologies as applied by Collings, et. al. ~~(1968)~~ 1972 and Waters (1976) and others (Stalnaker and Arnette, 1976) was that they were very labor intensive in the acquisition of hydraulic parameter information from the stream. During 1976, several researchers (Cochnauer, 1976; Dooley, 1976; Elser, 1976; Workman, 1976; White, 1976) began investigating the use of hydraulic modelling techniques to simulate hydraulic conditions at different discharges, with minimal time involvement in the field. Most of these investigators used the US Bureau of Reclamation's (USBR) Water Surface Profile Program (WSP) or the US Forest Service (USFS) single transect-sag tape program (R-2 CROSS). Many of the authors reported satisfactory results using the WSP model, although White (1976) questioned its accuracy over large ranges of

extrapolation. Bovee and Milhous (1978) likewise questioned the accuracy of stage (water surface elevation) predictions over a wide range of flows, while Bovee, et. al. (1977) and Elser (1976) suggested that the velocity predictions from WSP were neither accurate nor precise enough for microhabitat quantification, although they were satisfactory for macrohabitat modelling.

One of the major goals of the IFG was the improvement of the precision and accuracy of the state-of-the-art hydraulic simulation models, primarily in the prediction of horizontal velocity distributions. This goal has been accomplished through improvements made to the WSP (IFG-2) model and the development of a second, empirical hydraulic model (IFG-4). These two techniques represent a significant advance in the state of the art of microhabitat parameter simulation.

PHABSIM is the product of several disciplines working on different aspects of the same problem. It combines the use of hydraulic simulation models to predict distributions of depths, velocities, and substrates at different discharges. These distributions of variables are evaluated for habitat potential using weighted criteria as suggested by Waters (1968), although the system will accept binary criteria as well. Therefore, PHABSIM cannot be said to be a new system. Rather, it is the culmination and synthesis of several techniques which have been used and tested under a wide variety of conditions.

Testing of PHABSIM

The philosophy of the IFG is to encourage and assist field investigators in continually testing the various assumptions explicit in the methodology. The modular approach is specifically set up to enable modifications if particular relationships are shown to not be generally applicable. Several types of testing of PHABSIM and its components have been completed or are on-going. The IFG staff would appreciate additional opportunities to work with field investigators in analyzing their data. Tests can be broken down as follows:

1. Component testing:

    a. Testing the accuracy and precision of the hydraulic simulation models, particularly predictions of velocity.

    b. Testing the assumption of independence among variables as related to fish behavior in the selection of microhabitats.

    c. Testing the general applicability of the species specific habitat criteria.

2. Systems testing; testing the assumption that quality and quantity of habitat as defined by PHABSIM is correlated to biomass of fishes.

3. Applications testing;

    a. Test of applicability of PHABSIM in different environs, as to utility to fisheries resource managers, cost effectiveness, etc.

    b. Test of effectiveness. How well does PHABSIM displayed data meet the needs of the fishery manager in negotiations related to water use, impact analyses, or mitigation?

COMPONENT TESTING - HYDRAULIC MODELS

Several tests of the hydraulic models used in PHABSIM have been completed, while several more detailed tests are on-going. Bovee and Milhous (1978) tested the stage predicting ability of both IFG-2/WSP and IFG-4 hydraulic models and developed guidelines regarding extrapolative capabilities of both models. The theory and applicability of the models were reviewed by a group of professional hydraulic engineers (Simons and Li, 1979) at a workshop held at Colorado State University, November, 1978. They found that both techniques were theoretically sound, provided that the assumptions of rigid bed, and steady state hydraulics were not violated in their application. In addition, two studies have been initiated to determine the accuracy of the models in the prediction of hydraulic variables.

Yampa River Hydraulic Comparison Studies. IFG, in association with Colorado District USGS personnel, has collected extremely detailed hydraulic property information at two sites on Elk River, a headwater trout stream, and at four sites on the Yampa River which exhibits both middle and high order stream characteristics within Colorado. By summer's end, 1979, a minimum of three sets of detailed data will have been collected at each of the six sites. Predictive accuracy of the two hydraulic simulation computer programs used to create input to the PHABSIM program will be evaluated using empirical data as the comparison standard. The results will provide decision criteria for the selection of either of the programs relative to accuracy requirements and cost considerations or preferred uses in differing stream situtations.

Corps of Engineers (COE) Tailrace Studies. The FY 1979 effort will provide an additional data base for examining the predictive capabilities of the hydraulic simulation models, downstream from existing COE dams in Oklahoma and Kentucky. In addition, fish population data to be collected by the USFWS Reservoir Research personnel on these same stream reaches will be used to examine the relationship between biomass and habitat suitability.

COMPONENT TESTING - INDEPENDENCE AMONG VARIABLES IN THE SELECTION OF MICROHABITATS BY FISHES.

Both Collings' and Waters' treatments of criteria assumed independence in the selection of preferred instream station (focal point) among the important variables comprising the microhabitat conditions. Although this assumption has permeated methodological literature for ten years without question, the IFG has focused attention upon the mathematical theory (Grenney, 1979) resulting in an expressed need for critical examination of this general assumption (Patten, et. al., 1979).

This assumption has been tested using Pearson product-moment correlation analysis (Nie, et. al., 1975) on three species of fish for which a large amount of data was available (Grenney (1979), in preparation). Coefficients of determination (R^2 values) for the various tests are shown in Table 1.

These correlations are not large enough to raise serious concerns about the lack of independence for the available data. The univariate relationships currently used in the PHABSIM analyses represent the state-of-the-knowledge, are operational, functional, and appear valid. However, multivariate functions are being developed to accommodate dependencies, if any, as new data becomes available.

Table 1. Pairwise Pearson product-moment coefficients of determination, showing degree of dependence among environmental variables for three species of fish.

Species	Size Class (mm)	Sample Size	Velocity X Depth	Velocity X Substrate	Depth X Substrate
Whitefish	All	608	0.04	0.11	0.00
(*Prosopium*	<102	19	*	*	*
williamsoni)	103-203	117	0.03	0.01	0.01
	>204	472	0.04	0.13	0.00
Brown Trout	All	542	0.05	0.03	0.02
(*Salmo*	<102	73	0.02	0.05	0.04
trutta)	103-152	173	0.04	0.01	0.00
	153-203	130	0.07	0.10	0.01
	>204	162	0.14	0.01	0.02
Brook Trout	All	242	0.01	*	*
(*Salvelinus*	76-152	89	0.00	*	*
fontinalis)	>153	153	0.02	*	*

*Fewer than 20 sample points

SYSTEMS TESTING - CORRELATION BETWEEN WEIGHTED USABLE AREA (WUA) AND BIOMASS OF FISH

Two extensive field tests of PHABSIM have been completed, while another is in the analysis stage. Several others are pending.

Tom Wesche, Wyoming Water Resources Research Institute (WRRI), has provided the IFG with detailed cross-sectional data from 18 brown trout stream reaches and 22 brook trout stream reaches in Southeastern Wyoming. These measurements were accompanied by a wealth of population, biomass, and water quality data taken concurrently with the physical habitat data. Two analyses have been completed with this data, one for adult brown trout and one for adult brook trout.

Weighted criteria applied for the brown trout were from Istream Flow Iinformation Paper No. 4 (Bovee, 1978) developed primarily from data gathered in Idaho and Utah, while criteria for the brook trout were developed from data gathered by Wesche in Wyoming.

Brown Trout. WUA for adult brown trout was computed using depth, velocity, and substrate as state variables in the model. Temperature and water chemistry did not vary significantly. WUA for 18 brown trout reaches was highly correlated with biomass of adult brown trout (r=0.90). It was interesting to note that WUA explained much more variation in brown trout biomass than did percentage cover (r=0.11), even though brown trout are considered one of the more cover-oriented species.

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Brook Trout. A similar test was conducted correlating WUA for adult brook trout with adult brook trout biomass. This test seemed to confirm the findings of Dettman (1978), that temperature has a major role in determining fish distribution and abundance in marginal habitats. Many of the brook trout streams investigated by Wesche were marginal, either in terms of temperature or hydraulic parameters, but often not both at once. There was no correlation when WUA was computed using only depth, velocity, and substrate as state variables in PHABSIM. There was a weak (r=0.4) correlation between temperature and brook trout biomass. However, when temperature was included as a state variable in the computation of WUA, a significant correlation (r=0.80) between WUA and brook trout biomass was obtained.

Smallmouth Bass. A similar field test is in the final computation stages. Data from 12 reaches of the Maquoketa River near Manchester, Iowa, was provided by Vaughn Paragamian, Iowa Conservation Commission. The importance of this study should not be underestimated. PHABSIM was developed and tested using concepts known to be valid for trout streams. This test represents the first time any instream flow method has been tested against biomass estimates in a warm-water fishery.

Several similar studies are pending, subject to receipt of data by IFG. One such set of data has been offered by William Platts, USFS, Idaho, for numerous streams on the Idaho batholith (steelhead, rainbow trout, brown trout, cutthroat trout, whitefish, Dolley Varden, and several

minnow species). Another data set has been offered by Nicholson for several coastal streams in Oregon (coho salmon, steelhead, coastal cutthroat).

San Juan River Study. The USBR and Bureau of Indian Affairs are funding a series of contracts to assemble a comprehensive data base on 185 miles of the San Juan River below Navajo Dam in northwestern New Mexico. The physical habitat, water quality, sediment, periphyton and benthos, riparian vegetation and wildlife use, fish standing crop and recreation use will all be studied in depth, over range of flows and a fluctuating flow regime. The expected wealth of data and the flexibility in the water management capability of the reservoir offer great promise for testing various assumptions.

Oregon Anadromous Fish Studies. The Naional Marine Fisheries Service is leading a multi-agency effort to explore opportunities for enhancing anadromous salmon and steelhead reproduction in several major tributaries to the Columbia River. Assuming storage is built to enable enhancement flows for fish, prediction, verification analyses will be pursued.

APPLICATIONS TESTING

Appendix A contains river reach information and lists the principle investigators for instream flow applications of PHABSIM. Current applications and those planned through summer 1979 total 339 individual reaches

where PHABSIM has been, or will be applied. Locations of these reaches are shown in Figure 1 and summarized in Table 2.

Prior to the development of the incremental method, an Office of Biological Services (OBS) contract study was conceived and funded. Phase II of the project called for comparing several instream flow methodologies (utilizing flow records, single transects, multiple transects, and whatever additional analysis had been used in that state) in 13 western states. Most states have since adopted PHABSIM as the multiple transect method to be tested. The 13 western states have a total of 81 stream reaches in this "Phase II" effort. In addition, the state of West Virginia is pursuing a virtually identical study outside the OBS project. The results of these comparative studies are expected to provide some measure of the general applicability and effectiveness of the compared methods.

Preliminary cost estimates have shown that the collection of field data to operate PHABSIM, requires 2 to 6 man-days and approximately $500-$1,200 per reach. The time and dollar cost varies according to the size of the river, travel time, and type of hydraulic simulation used.

These applications have also shown that the typical fishery biologist is perfectly capable of collecting the type of data needed for PHABSIM. However, these applications have also shown that a "cook book" approach is no substitute for hands on training.

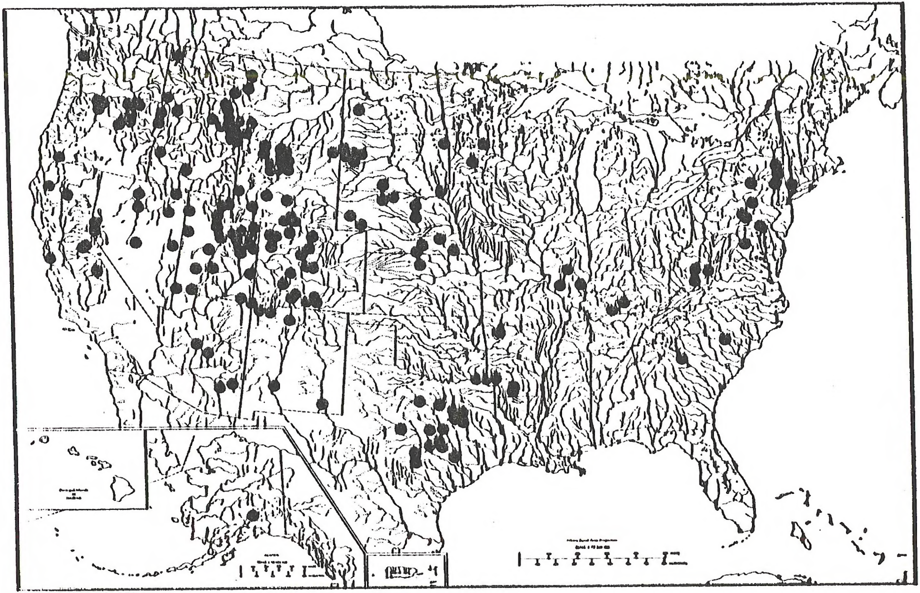

Figure 1. Locations of application of PHABSIM for instream flow analysis and related studies.

Table 2. Summary information on known applications of the IFG incremental method.

FWS Region	Number of River Reaches	Agency Offices Participating*
1	53	19
2	32	12
3	5	3
4	32	4
5	30	11
6	187	22
Total	339	71

*Each office of an agency was counted as an entity.

EFFECTIVENESS

Another valuable test of an instream flow method is whether or not the information provided enables the fishery manager to more effectively argue his case and negotiate with those representing other interests in the use of water. The purpose of an instream flow method is, after all, the quantification of flows to be left instream, not the prediction of standing crops, angler days, license revenues, or other econometric measures. However, in some cases, in order for the fishery manager to be effective, his arguments may need to be capable of addressing all of these. PHABSIM has the demonstrated ability for correlation of usable habitat with fish biomass, and therefore, with proper calibration, can be used in conjunction with econometric models. However, in most cases, decisions have been made on the basis of habitat changes alone. A few case histories are noted below to illustrate this point:

Foothills Water Treatment Plant (Colorado). Negotiations over a construction permit for the Foothills water treatment plant and associated Strontia Springs Dam on the South Platte River had been deadlocked for several years. Applicants for the permit (the Denver Water Board (DWB)) and opponents to the project could not agree on the instream flow requirement needed to mitigate the adverse effects of the reservoir and diversion project. Keith Rose, Salt Lake City Ecological Services (ES) Office, USFWS, was able to use PHABSIM to demonstrate the magnitude of habitat loss among alternative flow releases.

As a result of Rose's negotiations using output from PHABSIM, two federal lawsuits were dismissed based upon an out-of-court settlement among the various interest groups. The DWB agreed to provide instream flows as recommended by the USFWS (60 cfs from May 15 to September 15, and 30 cfs from September 16 through May 14). As a part of the settlement, the DWB also agreed to fund habitat improvement (up to $200,000 per mile) for the portion of the South Platte below Strontia Springs Dam based upon output from PHABSIM, which demonstrated the potential habitat gains obtained by altering channel configurations.

Texas Base Flow Negotiations. Denwood Butler, Fort Worth ES, USFWS, used PHABSIM output to negotiate base flow releases from COE reservoirs in Texas. Texas has no provision for reserving instream flows in its water law. However, because it is a riparian doctrine state, Texas requires the passage of a base flow through all reservoirs.

In the past, this base flow has amounted to whatever seeped through or under the dam while the gates were closed. While the COE is bound by law to release a base flow, it is relying on a strictly hydrologic definition of base flow. Butler is using PHABSIM to define a biological base flow. Although no decision has been made (the Clear Fork of the Trinity River will be the first test case), Butler feels that the information provided by PHABSIM has enabled him to maintain solid footing in the negotiations.

San Luis Conveyance Channel (Colorado). The USBR proposes a canal carrying pumped groundwater to provide stream flow requirements to fulfill obligations of Colorado to the Rio Grande Compact and treaty obligations with Mexico. PHABSIM was used to evaluate ten alternative canal designs to determine which would provide the best habitat for brown or rainbow trout. This cooperative effort between the USBR, USFWS, and Colorado Division of Wildlife, could result in a trout fishery in a proposed 43 mile canal.

James River Diversion (Missouri). Jim Hendrickson, Kansas City ES, USFWS, has utilized PHABSIM output to evaluate the impact of a proposed diversion from the James River to supply municipal water. As a result of his analysis, the COE approached Hendrickson to write portions of the Environmental Impact Study (EIS). Hendrickson was able to incorporate several previously unconsidered alternatives in the impact study. The first alternative recognizes the USFWS's recommended instream flow regime. This alternative has been reviewed by the USGS and determined to be feasible by augmenting the municipal water supply with pumped ground water when surface water supplies approach the recommended instream flow requirement. Surface water could be diverted when supplies exceed the instream flow recommendations. A second alternative recognizes two instream flow plans, one for near normal water years and one for drought years. Under both alternatives, the city would initiate strong water conservation measures whenever the stream flow approached the recommended instream flow. During a normal water year, these measures would be

instituted at relatively high stream flows as compared to low water years. This alternative would have the effect of diffusing the impact over all the water uses instead of concentrating it on the fishery. The draft EIS will be available for public comment around July 1, 1979.

Hendrickson attributes the inclusion of these two new alternatives to his use of PHABSIM. He states that he was better prepared to enter these negotiations than he has been for any other.

Trinity River (California). Jody Hoffman, Sacramento ES, USFWS, served on the Trinity River Basin task force. This task force was composed of members of 14 state and federal agencies, representing a wide variety of water use interests, including state and federal water development agencies. The Trinity River represented a severely degraded habitat. Flow releases from the existing dam averaged approximately 15% of the average annual discharge. In addition, the upper four miles were subject to sedimentation of fine materials from several timber clear-cuts in the area.

Hoffman used PHABSIM output to suggest that the amount of habitat for holding adult steelhead and for rearing steelhead smolts could be increased 200 to 300% by increasing flows from the present 150 cfs to 250 cfs during the rearing season. He also recommended the release of 500 cfs during the spawning season. PHABSIM was used to illustrate improvements in spawning area by removal of the fine sediment from the upper four

miles of the tailwater. This analysis was used to propose and support construction of debris dams to intercept sediment before it reached the Trinity.

Hoffman's proposals were reviewed and endorsed by the task force by a vote of 13-1. These proposals were included in a Scretarial Decision Document, which has been submitted to the Department of Interior in Washington, DC. Although no decision has been made concerning the Trinity, Hoffman states that PHABSIM was instrumental in elevating an instream flow recommendation to the highest possible level.

Green River (North Dakota). The Versipi Dam is a proposed storage facility on the Green River, a small stream near Dickinson, North Dakota. Al Ludden, Bismarck ES, USFWS, was assigned to develop a mitigation plan for the project under Fish and Wildlife Coordination Act authority.

Ludden made two assessments of the project. He first used a temperature model to determine the thermal regime of the river. He found that temperatures would be low enough to justify stocking trout in the stream. However, when PHABSIM was applied to his data, it was found that under the proposed release pattern there would be very limited amounts of trout habitat available. He further ascertained that spawning in the river would be highly doubtful under any flow regime.

His mitigation plan included (1) a higher flow release pattern to provide as much trout habitat as possible under the constraints of water supply, (2) stocking of fingerling rainbow trout on an annual basis, and (3) deepening of existing pools to provide additional trout habitat. Ludden feels his recommendations have been accepted, although a final decision has not been made.

It is difficult to assess how the outcome of these negotiations have been influenced by use of PHABSIM as opposed to a receptive audience within the construction agencies. However, each of the biologists interviewed in the preceding case histories felt that the persons they dealt with were more receptive to their ideas because of the ability to display how habitat varies with flow and the nature of the analysis is understandable to the decision makers. Each felt that this is an effective, efficient tool for their individual problems.

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Appendix A
Applications of IFG Incremental Method[1]

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Region 1		
Alaska	Susitna R. - Watana dam site to mouth (19050002)	FWS (Norval Netch, 8-399-0150 ask for 907-276-3000)
		Alaska DNR (Brent Petrie and Greg Doggett considering initiation of program of study in Spring 1979) ext 307/
California	Trinity R. - from 2 to 22 miles below Clair Engle Res. Long 123° Lat 40° 45' (18010211)	BR/FWS (ES-Sacramento) (Jody Hoffman, 8-468-4731)
	San Lorenzo R. (18060001)	Santa Cruz Co. (John Ricker)
	N. Fk. Stanislaus R. - 14 miles above New Melones Res. (18040010)	Calavras Co Water District (D. W. Kelly, 916-443-3781 & K. S. Dunbar, 209-754-3543)
	N. Fk. Stanislaus R. - 9 miles above New Melones Res. Long 120° 20' Lat 38° 10' (18040010)	FWS (ES-Sacramento) (Gwill Ging, 8-468-4731)
	Cottonwood Cr. - Trib. to Sacramento R., 30 miles below Shastan Res. Long 122° 20' Lat 40° 22' (18020102)	FWS (ES-Sacramento) (Tim Richardson, 8-468-4731)
	Dinkey Cr. - in Fresno Co. - Trib to Pine Flat Res. on Kings R. Long 119° 10' Lat 36° 50' (18030010)	California Fish & Game, Fresno (Dennis Lee) and FWS (ES-Sacramento) (Jody Hoffman)

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*Collecting Standing Crop Data
§Comparing Methodologies

[1] A computerized data file IFIS(Q) currently envisioned will be accessed by WELUT's MANAGE program. Clients will be able to query the data file by WRC hydrologic unit code, FIPS code, agency, and date of entry (i.e., entries since a given data).

May 15, 1979

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Hawaii		
Idaho	§ Snake R. - Confl. Grand Ronde - RM 139.3 - to Lower Granite Pool - RM 168.5 (17060103) § Clearwater R. - RM 15.1-40.4 (17060306) § S. Fk. Clearwater - RM 0.0-11.4 (17060304) § Big Wood R. - RM 5.0-34.2 (17040219) § Boise R. - RM 32.4-40.4 - near Eagle (17050115) § Hayden Cr. - Trib. to Hayden Lake - RM 0-25 (17010305)	ID F&G (Phase II Contract) (Tim Cochnauer & Bill Horton)
	Big Lost R. - on Idaho National Engineering Laboratory Site (170402_ _)	INEL (David Cannamela and Donald Johnson)
Nevada	§ Steptoe Cr. - White County (16060008) § Kingston Cr. - Lander County (16060004) § Lamoille Cr. - Elko County (16040101) § Humbolt R. - Elko County (16040101) § Humbolt R. - Humbolt County (16040105 and 16040108) § S. Fk. Little Humbolt R. - Elko County (16040103) § Salmon Falls R. - Elko County (17040213) § E. Fk. Carson R. - Douglas County (16050201)	NV F&G (Phase II Contract) (Dale Lockard)
	Truckee R. - Lake Taho to Pyramid Lake (16050102)	FWS (FS-Reno) (Gary Scoppettone, FWS 8-470-5227) w/ USGS (Carson City) (Larry Smith)
Oregon	Umatilla Basin Umatilla Main Stem at: (17076103) 1. Echo, OR (17076103) 2. Yoakum, OR (17076103) 3. Reith, OR (17076103) 4. Pendleton, OR (17076103) 5. Umatilla, OR (17076103)	FWS (FS-Vancouver) (Dick Harper, 8-422-7605)

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Oregon (Continued)	6. Above Meacham Cr. (17076103)	
	7. Above Squaw Cr. (17076103)	
	8. At Cayuse, OR (17076103)	
	Tributaries	
	1. S. Fk. of the Umatilla R. (17076103)	
	2. N. Fk. of the Umatilla R. (17076103)	
	3. Butter Cr. at Pine City, OR (17076103)	
	4. Brich Cr. at Pilot Rock (17076103)	
	5. Squaw Cr. (17076103)	
	6. Meacham Cr. (17076103)	
	7. McKay Cr. (17076103)	
	Grande Ronde Basin - selected reaches to test influence of riparian habitat on late summer rearing of anadromous fish (17060104) *	NMFS (Steve Smith, 8-429-4311), FWS (Rick Bracy), ODFG (Tom Nickelson), BR (Tom Pick, Salem)
	§ Deschutes Basin	
	Buck Hollow Cr. - Trib. to Lower Deschutes - lower 20 mi. (17070106)	
	Bakeoven Cr. - Trib. to Lower Deschutes at Maupin - lower 15 mi. (17070306)	
	Trout Cr. - Trib. to Deschutes near Gateway - lower 50 mi. (1707307)	
	§ Umatilla Basin	
	Umatilla R. - 3 mi above confl. of Fks near Bingham Springs to Pendleton (17070103)	
	Meacham Cr. - Meacham to mouth (17070103)	
	McKay Cr. - headwater to McKay Res. (17070103)	
	§ John Day Basin	
	S. Fk. John Day R. - Izee to mouth - 35 mi. (17070201)	
	M. Fk. John Day R. - Austin to confl. with N. Fk. - 70 mi. (17070203)	

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Oregon (Continued)	N. Fk. John Day R. Cont. with Camas Cr, to mouth at Kimberly - 55 mi. (17070202)	
	Camas Cr. - Ukia to confl. with N. Fk. - 11 mi. (17070202)	
	John Day R. - S. Fk. confl. at Dayville, RM 160, to Service Cr., RM 120 (17070201 and 17070204)	
	Fifteenmile Cr. (17070105)	
	Applegate R. (17100309)	Oregon DF&W (Steve Kramer, 503-754-4431)
Washington	N. Fk. Skokomish R. - L. Cushman Dam to mouth - 8.5 miles (17110017)	FWS (FS-Olympia) (Phil Wampler, 8-434-9460)
	S. Fk. Skokomish R. - lower 16 miles (17110017)	
Region 2		
Arizona	Verde R. - Bartlet Dam to Phoenix (15060202)	Indians/FWS Ripairna Group (John Peterson, et al., 8-474-2914)
	§ Verde R. (15060202)	AZ F&G (Phase II Contract) (Donna Hayes)
	§ Black R. (15060101)	
	§ Arivaipa Cr. (15050203)	
	§ West Clear Cr. (15060203)	
	Colorado R. - Glen Canyon Dam	FWS/ES (Frank Baucum)
	Colorado R. - Hoover Dam	
New Mexico	§ Rio Grande - Elephant Butte Dam to Caballo Res. (13030101)	NM F&G/U of NM (Phase II Contract) (Paul Turner, 8-474-5511 ask for 646-1707)
	§ San Juan - at Archeleta (14080101)	
	§ Rio Chauma - below El Vado Dam (13020102)	
	San Juan - Navajo Dam to Mexican Hat (14080105)	* BR/BIOWEST (Chuck Solomon, 8-734-2294 & Paul Holden, 8-588-5500 ask for 752-4202)
	Pecos R. - between Lake McMillam and Lake Avelon (13060011)	BR (Bob Black, 8-584-0282)
	Red R. - Fish Hatchery to MO (4 mi.) (130201_ _)	BLM (Herb Garn and Paul Cuplin, 8-234-4620)

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Oklahoma	§ Glover R. - near future dam site (11140109)	* Coop Fish Res Unit (Phase II Contract) (Gene Maughn)
	Mt. Fk. R. - below Pine Cr. Lake (11140109)	* FWS (Fayetteville) w/CE (Vicksburg) (Gary Saul, CE)
Texas	§ Clear Fk. Trinty R. - Benbrook Dam to Hwy Loop 820 (12030102) § Brazos R. - Hwy 180 to Granbury Res. (12060201) § Trinity R. - Rosser to Hwy 7 west of Crockett (12030105 and 01) § Guadalupe R. - Kerrville to Canyon Lake Res. (12100201) § Colorado R. - Confl. Concho R. to Confl. Pecan Bayou (12090106) § Rio Blanco - Wimberly to Confl. San Marcos R. at County line (12100203)	FWS (ES-Ft. Worth) (Phase II Contract) (Denwood Butler, 8-334-2961)
	Brazos R. - Lake Whitney Dam to Waco (12060202) Leon R. - Belton Dam to Confl. Little R. (12070201) Leon R. - Proctor Dam to Belton Res. (12070201) E. Fk. Trinity R. - Lake Lavon Tailrace (12030106) E. Fk. Trinity R. - Forney Dam to Confl. Trinity R. (12030106) Waxhachie Cr. - Below Bardwell Lake (12040109) Richland Cr. - Navarro Mills Dam to Confl. Trinity R. (12030108) Yegue Cr. - Somerville Dam to Confl. Little R. (12070102) Lampasas R. - Stillhouse Hollow Dam to Confl. Little R. (12070203) San Gabriel R. - Granger Dam to Confl. Little R. (12070205) N. Fk. San Gabriel R. - N Fk. Dam to Confl. San Gabriel R. (12070205)	FWS (ES-Ft. Worth) (Planned for 1979) (Denwood Butler)
Region 3		
Illinois	Kaskaskia - from Lake Shelbyville to Carlye Res. (07140202) Kaskaskia - Carlye Dam to Fayetteville (07140202 and 07140204) L. Wabash - from Louisville to Carmi (05120114)	U of IL (Ed Herricks, 8-957-0997) with IL Department of Transportation (Chuck Flow)

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Indiana		
Michigan		
Minnesota	Mississippi R. - St. Cloud to confl. with Rum R. at Anoka (07010203) Minnesota R. - Granite Falls to Mankato (07020004 - 07020007)	MN DNR (Joe Geis, 8-776-0784)
Ohio		
Wisconsin		
Region 4		
Alabama		
Arkansas	Cossatot R. - below Gillham Res. (1140409) White R. - below Beaver Res. (11010001) Caddo R. - below DeGray Res. (08040102) L. Missouri R. - below Lake Greeson (08040103)	* FWS (Fayetteville) w/CE (Vicksburg) (Gary Saul, CE)
Florida		
Georgia	Savannah R. - below Hartwell Res. (03060103)	* FWS (Fayetteville) w/CE (Vicksburg) (Jerry Novotney, Bowling Green, KY and Gary Saul, CE)
Louisiana		
Mississippi		

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
North Carolina & South Carolina	Yadkin - Peedee R. Level B Study Area (030402) (25 reaches yet to be selected)	FWS (ES-Raleigh) (Richard Jones, 8-672-4520) FWS (ES-Charleston) (Diane Dunn, 8-677-4707)
Kentucky	Green R. - below Green R. Res. (05110001) Barren R. - below Barren R. Res. (05140203)	* FWS (Fayetteville) w/CE (Vicksburg) (Jerry Novotney, Bowling Green, KY and Gary Saul, CE)
Tennessee		
Region 5		
Connecticut		
Delaware		
Maine		
Maryland	Monocacy R. - Trib. to Potomoc - lower 53 miles in Frederic, Carroll, and Montgomery Counties (0207008) Potomac R. - 23 miles Savage R.	U of MD (Fred Kuss, 8-202-454-2354)
	Susquehanna R. - below Cowingo Dam (02050306)	Susquehanna RBC (Richard Jackson) w/ FWS (ES-Harrisburg) (Rick McCoy), MD DNR (John Foster), PA DER (Fred Johnson), FWS (ES-State College) (Steve Goodbred), FWS (Region 5) (Jerry Taylor)
Massachusetts		
New Hampshire		
New Jersey		

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
New York	Hudson R. Basin	NY Dept. of Env. Cons. (Div. of Fish & Wildlife) (Doug Sheppard, 8-562-4411 ask for 518-457-5698)
	Schoharie Cr. - Schoharie Dam to Blenheim-Gilboa Res. (02020005)	
	Schoharie Cr. - Blenheim-Gilboa Dam to Middleburg (02020005)	
	Esopus Cr. - NYC Portal Downstream to Askokan Res. (02020006)	
	Esopus Cr. - below Askokan Dam (02020006)	
	Rondout Cr. - Rondout Dam downstream 15 miles (02020007)	
	Boyd's Corner Outlet - Boyd's Corner Dam to W. Branch Res. (02030101)	
	W. Branch Outlet - W. Branch Dam to Muscoot Res. (02030101)	
	E. Branch Croton R. - E. Branch Dam to Diverting Res. (02030101)	
	E. Branch Croton R. - Diverting Dam to Muscoot Res. (02030101)	
	Amawalk R. - Amawalk Dam to New Croton Res. (02030101)	
	Croton R. - New Croton Dam to Confl. with Hudson R. (02030101)	
	Deleware R. Basin	
	W. Branch Deleware R. - Cannonville Dam to Hancock - (02040101)	
	E. Branch Deleware R. - Pepacton Dam to Hancock - 35 mi. (02040102)	
	Neversink R. - Neversink Dam to Bridgeville - 21 mi. (02040104)	
	Black Lake Cr. - Toronto Dam to Cliff Lake (02040104)	
	Black Lake Cr. - Cliff Lake to Mongaup Falls Res. (02040104)	
	Mongaup R. - Swiningbridge Dam to Confl. with Black Lake Cr. (02040104)	
	Mongaup R. - Mongaup Falls Dam to Rio Res. (02040104)	
	Mongaup R. - Rio Dam to mouth (02040104)	
Pennsylvania	Yellow Breeches Cr. - near Camp Hill (02050305)	FWS (Jerry Taylor & Rick McCoy) w/ Susquehanna RBC (Richard Jackson, 717-238-0425)
	Condoguinet Cr. - at Hogestown (02050305)	
	Susquehanna R. - at Danville (02050305)	
Rhode Island		

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Vermont		
Virginia	Potomac R. (02070010 and 02070011)	FWS (ES-Annapolis) (Steve Goudbred), w/ MD DER (Dave Smith), VA EPA (?)
West Virginia	§ New R. (05050004) § Meadow R. (05050005) § Greenbriar R. (05050003) (also 13(a))	WV F&G (Ray Mendez and Dan Cincotta, Elkins, 204-636-1767)
Region 6		
Colorado	Yampa R. - Craig to Lily (14050002) Elk R. - Clark to mouth (14050001)	USGS (Denver) (Dan Bauer) with EPA (Corvallis) (Mostafa Shirazi)
	South Platte R. - S. Platte to Chatfield Res. (10190002) S. Fk. Cache la Poudre R. (10190007) Trib. & Pass Spring Cr. (11020006) Cucharas R. - above Middle Cr. (11020006) S. Fk. Rio Grande - Pass Cr. to Beaver Cr. (13010004) S. Fk. Carnero Cr. (13010004) Sangre De Cristo Cr. (13010002) Lake Fk. Gunnison R. - Henson Cr. to Blue Mesa Res. (14020002) East R. - Cement Cr. to Gunnison R. (14020001) S. Fk. Fryingpan R. (14010004) N. Fk. Fryingpan R. (14010004) Cunningham R. (14010004) Fryingpan R. - from Ruedi Dam to Roaring Fk. R. (14010004) Williams Fk. - Colorado R. above Keyser Cr. (14010001) St. Louis Cr. (14010001)	§* CO F&G (Phase II Contract) (Barry Nehring, 8-327-0111 ask for 303-249-3431)

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
	S. Platte R. - Strontia Spring Dam to Kassler (10190002)	CO Div. of Wildlife (Rex Talifaro,8-234-3131 ask for 825-1192), FWS (ES-Salt Lake City) (Keith Rose, 8-588-5637)
	Yampa R. - Craig to Lily (14050002)	BLM/CSU (Mike Prewitt)
	White R. - Piceance Cr. to Yellow Cr. Confl. (14050007)	
Iowa		
Kansas	Solomon R. - Below Confl. of Fks. (10260015)	FWS (ES-Kansas City) (Jim Armstrong & Jim Luty, 8-758-5951)
	N. Fk. Solomon R. - Above Confl. (10260012)	
	S. Fk. Solomon R. - Above Confl. (10260014)	
Missouri	Big R. - Pine Ford Dam site to (07140104)	FWS (ES-Kansas City) (Corlin Cook, 8-758-5951)
	James R. - Prearson Cr. Confl. to Lake Springfield (11010002)	
Montana	Marias R. - Tiber Res. to mouth (10030203)	* MT F&G (Phase II Contract) (Larry Peterman and Fred Nelson, 406-232-4365)
	§ Bighole R. - Jackson to Pinther Cr. Confl. (10020004)	
	§ Bighole R. - Pintler Cr. Confl. to Confl. Divide Cr. (10020004)	
	§ Bighole R. - Divide Cr. Confol. to Confl. Jefferson R. (10020004)	
	Ruby R. - Ruby Res. to mouth - 2 reaches (10020003)	
	Jefferson R. - headwaters to Confl. Boulder R. (10020005)	
	Jefferson R. - Boulder R. to mouth (10020005)	
	Boulder R. - lower 5 miles (10020006)	
	Prickley Pear R. - headwaters to E. Helena (10030101)	
	§ West Gallatin R. - Gateway to Confl. with E. Gallatin (10020008)	
	§ Madison R. - Earthquacke Lake to NW Corner T10S, R1E (10020007)	
	§ Madison R. - Ennis Lake to mouth (10020007)	
	East Gallatin R. - baseline to Confl. with Gallatin R. - 2 reaches (10020008)	
	Little Prickley Pear R. - Canyon Cr. to Mouth - 3 reaches (10030101)	

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Montana (Continued)	Belt Cr. - Monarch to Confl. Big Willow Cr. (10030105)	
	Missouri R. - Ft. Benton to Confl. with Marias R. at Loma (10030102)	
	Missouri R. - Loma to Fort Peck Res. (10040101 and 10040104)	
	Clark Fork - 6 miles below Ramsey to Garrison (17010201)	
	Warm Springs Cr. - headwaters to Confl. with Clark Fk. (17010201)	
	§ Beaverhead R. - Clark Canyon Dam to Diversion 2½ miles below Grasshopper Cr. (10020002)	
	Madison R. Watershed, at:	USFS, Gallatin NF/Contractors (Steve Glasser, 8-585-4384)
	1. S. Fk. Madison R. - below highway bridge (10020007)	
	2. W. Fk. Denny Cr. - at forest boundary (10020007)	
	3. Watkins Cr. - at forest boundary (below Ruof ditch) (1002007)	
	Gallatin R. Watershed, at:	
	1. Bozeman Cr. - above city diversion (10020008)	
	2. Hyalite Cr. - above city diversion (10020008)	
	3. S. Fk. Spanish Cr. - at forest boundary (10020008)	
	4. Hellroaring Cr. - above highway (10020008)	
	5. Procupine Cr. - near mouth (10020008)	
	6. Squaw Cr. - near mouth (10020008)	
	7. Taylor Fk. - at gaging station (10020008)	
	8. Cache Cr. - above Taylor Fk. road (10020008)	
	9. Swan Cr. - near mouth (10020008)	
	10. W. Fk. of Gallatin R. - near mouth (10020008)	
	11. S. Cottonwood Cr. - above Bartosch property (alternate location is at the gaging station) (10020008)	
	12. Buck Cr. - above highway (10020008)	
	Yellowstone R. Basin, at:	
	1. Shields R. - below Crandall Cr. (10070003)	
	2. Cottonwood Cr. - above Pauline Cr. (10070003)	
	3. Rock Cr. - above Middle Fk. (10070003)	

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§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Montana (Continued)	4. Brackett Cr. - Below South Fk. (10070003)	
	5. Mill Cr. - at Forest Service gaging station - Snowbank CG (10070002)	
	6. E. Fk. Mill Cr. - ¼ mile above mouth (10070002)	
	7. Bear Cr. - below Jardine (10070001)	
	8. Rock Cr. - in Sec. 14, T7S, R6E above Stoughten Cr. (10070002)	
	9. Big Cr. - in Sec. 18, T6S, R7E above Mill Fk. Cr. (10070002)	
	10. E. Boulder R. - at forest boundary (10070002)	
	11. Big Timber Cr. - at guard station near forest boundary (10070002)	
	12. S. Fk. Big Timber Cr. - near forest boundary (10070002)	
Nebraska	§ N. Platte R. - WY Stateline to Lewellen (10800019)	NE F&G (Phase II Contract) (Phil Hilgert)
	§ Nine Mile Cr. - in Scottsbluff County (10800019)	
	§ Niobrara R. - Norden to Confl. Keya Paha R. (10150004)	
	§ Snake R. - Merritt Dam to Confl. Niobrara R. (10150005)	
	§ Long Pine Cr. - in Brown County (10150004)	
	§ Elkhorn R. - Ewing to Norfolk (10220001)	
	§ Republican R. - (Courtland Diversion to KS stateline (10250016)	
	§ L. Blue R. - Ayr to KS stateline (10270206 & 10270207)	
	§ Cedar R. - Headwaters to Fullerton (10210010)	
	§ W. Fk. Big Blue R. - Stockham to Confl. Big Blue R. (10270203)	
	§ N. Fk. Big Nemaha R. - Tecumseh to Salem (10240008)	
North Dakota	Green R. - Whole-stream, Trib. Heart R, (10130201)	FWS (ES-Bismark) (Al Ludden)
South Dakota	§ Rapid Cr. - Pactola Dam to Rapid City (0120110)	SD F&G (Phase II Contract) (Ron Glover)
	§ Rapid Cr. - confluence of N. & S. Fk. to Pactola Res. (0120110)	
	§ Castle Cr. - Derrfield Res. to Rapid Cr. (0120110)	
	§ Whetstone R, - Confl. of N.F. to MN Stateline (07020001)	

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State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
South Dakota (Continued)	§ Big Sioux R. - Klondike Dam to Missouri R. (10170203)	
	§ Little White R. - Tuthill to the White R. (10140203)	
	§ Cheyenne R. - Confl. of Belle Fourche R. to Lake Oahe (10120112)	
	§ Belle Fourche - . (WY stateline to Cheyenne R. (10120202)	
	§ Spearfish Cr. - Homestake Hydro Elec. Plant to Redwater R. (10120203)	
	§ Big Sioux R. - Klondike to Lake Kampeska (10170202)	
	Vermillion R. - Confl. of E. & W. Fk. to Ridge Cr. (10170102)	
Utah	§ Blacksmith Fk. Logan R. (16010208)	UT F&G (Phase II Contract) (Bill Geer, 8-588-5500 ask for 533-9333
	§ Farmington Cr. (16020102)	
	§ Provo R. - Deer Cr. Dam to above Springdale (16020203)	
	§ Duchesne R. - W. Fk. Confl. to below Tabiona (14060004)	
	§ Green R. - at Jensen (14060001)	ECI (Phase II Contract) (Randy Crawford, 303-482-1973)
	§ Green R. - near Sand Wash and Florence Cr. (14060005)	
	Bonneville Basin	BR (Bob Black, 8-584-0282)
	Provo R. - 16 stations 75 mi. - headwaters to Deer Cr. Res. (16020203)	
	N. Fk. Provo Cr. - headwaters to Confl. with Provo R. (16020203)	
	Sixth Water Cr. - 2 stations, 10 mi. - Strawberry Res. Diversion to Confl. Fifth Cr. (16020202)	
	Diamond Fk. - 3 stations - 9 miles above confl. to confl. with Spanish Fk. (16020202)	
	Spanish Fk. R. - 3 stations, 21 mi. - (Diamond Fk. Confl. to Utah Lake (16020202)	
	Uintah River Basin	
	Strawberry R. - 6 stations - Headwaters to Strawberry Res. 12½ mi. (14060004)	

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State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Utah (Continued)	Strawberry R. - Starvation Dam to Confl. with Duchesne 5 mi. (14060004)	
	Strawberry R. - Soda Cr. Dam to Confl. with Red Cr. 19 mi. (14060004)	
	Current Cr. - 5 stations, 27 mi. - Current Cr. Dam to Red Cr. Confl. (14060004)	
	W. Fk. Duchesne - 3 stations, 10 mi. - VAT Diversion to Confl. with N. Fk. Duchesne (14060003)	
	Wolf Cr. - 1 station, 3 mi. - Rhodes Diversion to Confl. with W. Fk. Duchesne (14060003)	
	N. Fk. Duchesne - 1 station, 3 mi. - Siphon to Confl. to Confl. with Rock Cr. (14060003)	
	Duchesne R. - 2 stations, 15 mi. - N. & W. Fk. Confl. to Confl. with Rock Cr. (14060003)	
	Rock Cr. - 5 stations, 26 mi. - Upper Stillwater Dam to Confl. with Duchesne (14060003)	
	Lake Fork R. - 3 stations - Moon Lake to Confl. with Yellowstone Cr. (14060003)	
	Yellowstone (UT) R. - 2 stations - Boneta Diversion to Confl. with Lake Fk. (14060003)	
	Uintah R. - 4 stations, 40 mi. - Uinta Dam site to Confl. with Duchesne (14060003)	
	White Rocks R. - 1 station, 10 mi. - White Rocks Dam site to Confl. with Uinta (14060003)	
	Severe R. - Reach undetermined, scheduled for 1979 (16030005)	
	Uintah R. - on Uintah-Ouray Indian Reservation - 2 mi. above Confl. with White Rocks R. (14060003)	BR/IFG (Dave Wegner, 8-323-5231)

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State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Utah (Continued)	Green R. Basin	BLM (Don Duff, 8-588-4033)
	Below Flaming Gorge Dam	
	Jackson Cr. - in extreme NE Utah (14040106)	
	Willow Cr. - in extreme NE Utah (14040106)	
	Beaver Cr. - in extreme NE Utah (14040106)	
	Unnaumed Cr. - in extreme NE Utah (14040106)	
	Mill Cr. - below Dam, near Moab, UT (14030005)	
	White R. - (Stateline to Indian Res.) (14050007)	
	Pariette Draw - Trib. to Green R. (14060005)	
	Rock Cr. - Trib. to Green R. in Desolation Canyon (14060005)	
	Virgin R. Basin	
	Beaver Dam Wash (15010010)	
	Leeds Cr. (15050010)	
	North Cr. (15010008)	
	Bear R. Basin	
	Big Cr. (16010101)	
	N. Fk. Otter Cr. (16010101)	
	Middle Fk. Otter Cr. (16010101)	
	S. Fk. Otter Cr. (16010101)	
	Randolf Cr. (16010101)	
	Trout Cr. - closed basin near Nevada line (16020306)	
	Birch Cr. - closed basin near Nevada line (16020306)	
	Beettridge Cr. - clossed basin near Nevada line (16020308)	
	Otter Cr. - above Otter Cr. Res. in Piute Co. (16020002)	
	Brich Cr. - Trib. to Beaver R. east of Beaver, UT (16030007)	
Wyoming	§ Green R. - Fontenelle Dam to Flaming Gorge Res.	* WY F&G (Phase II Contract) (Bob Wiley and Robert Pistono, 307-745-4046)
	§ Sweetwater R. - Headwater to Alkali Cr.	
	§ Encampment R. - CO stateline to Forest Service Boundary	
	§ Belle Fourche R. - Keyhole Dam to SD stateline	

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State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Wyoming (Continued)	State wide program to start in 1979	Contract to WY F&G (Richard McQuiston)
	Thomas Fk and Tribs. (16010102)	BLM (Rock Springs District)
	Vermillion Cr. (14040109)	
	Coyote (14040109)	
	Canyon Cr. (14040109)	
	Cherry Cr. (10180006)	BLM (Rawlings District)
	Pete Cr. (10180006)	
	Muddy Cr. (14050004)	
	McKinney Cr. (14050004)	
	Sage Cr. and Tribs. (10180002)	
	Clark's Fk. - Yellowstone R. (10070006)	BLM (Worland District)
	Gooseberry Cr. (10080007)	
	Cottonwood Cr. (10080007)	
	N. Fk. Owl Cr. (10080007)	
	S. Fk. Owl Cr. (10080007)	
	Wind R. (10080007)	
	Trout Cr. (10080008)	
	Lost Cr. (10080008)	
	Canyon Cr. (10080008)	
	Otter Cr. (10080008)	
	Spring Cr. (10080008)	
	Canyon Cr. - Trib. to Tenshep Cr. (10080008)	
	N. Fk. Brokenback Cr. (10080008)	
	S. Fk. Brokenback Cr. (10080008)	
	Rock Cr. (10080008)	
	Medicene Lodge Cr. (10080008)	
	Nowood R. (10080008)	
	Trapper Cr. (10080010)	
	White Cr. (10080010)	

*Collecting Standing Crop Data
§Comparing Methodologies

State	River Reaches (WRC Hydrologic Unit)	Agency (Principle Investigator)
Wyoming (Continued)	Bighorn R. (10080010) Five Spring Cr. (10080010) Procupine Cr. (10080010) Deer Cr. (10080010) Trout Cr. (10080016) N. Fk. Shoshone (10080012)	
	Wind R. - Confl. with E. Fk. to Boyson Res. (10080001) Bull Cr. - Bull Lake Dam to Wind R. - 3 mi. (10080001) Little Wind R. - Confl. of N. Fk. and S. Fk. to Wind R. (10080002)	FWS (FS-Lander) (Dick Baldus, 8-328-1110 ask for 307-332-2159) On Wind R. Indian Reservation

*Collecting Standing Crop Data
§Comparing Methodologies

REPORT OF INSTREAM FLOW STUDY

Principal Investigator(s): ____________________ Agency: __________

Mailing Address: ______________________________

Phone: Comm______________ FTS______________

State: ______________

WRC Hydrological Cataloging Unit(s) Code (an 8-digit number) or County: __________

____

____

River Name: ______________________________

River Reach: from______________ to______________
upstream point downstream point

______________ to______________

______________ to______________

Method(s) Employed:

IFG Incremental Method
- __ PHABSYM (IFG-2) (WSP)
- __ PHABSYM (IFG-4)
- __ W.Q. Model
- __ Tennant (Montana Method)
- __ R-2X
- __ Oregon Method
- __ Other Specify:__________

Is Copy of the Study Plan Available: ______________________________

Are Standing Crop or Other Biological (Specify) Data Being Collected: Yes__ No__

List Species ______________________________

Are Criteria Data Being Collected: Yes__ No__ List Species/Activities: __________

____

Area Water Quality Data being Collected: Yes__ No__ List Parameters __________

____

Anticipated Completion Date: __________ Anticipated Publication Date:__________

Where Will Field Mreausrements and Data be Kept: ______________________________

If a Central Storage File were Made Available, Would You Contribute Your Field Data:
Yes ___ No ___

In What Form: ______________________________

Purpose of Instream Flow Study:
- Water Rights Quantification ___
- Impact Analysis ___
- Mitigation Formulation ___
- Other (specify) ___

Return To:
Keith Bayha
Instream Flow Group
2625 Redwing Road
Fort Collins, CO 80526

INTER-AGENCY WATER MANAGEMENT SYSTEMS

Myron Molnau
Professor & State Climatologist
Agricultural Engineering Department

University of Idaho
Moscow, Idaho 83843
(208)-885-6182

Bureau of Land Management
Great Basin Watershed Workshop

Elko, Nevada
November 5-8, 1979

College of Agriculture
UNIVERSITY OF IDAHO
College of Engineering

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Interior
DEC 03 1979
Land Management
State Office
Boise Idaho

INTER-AGENCY WATER DATA MANAGEMENT SYSTEMS

Myron Molnau

I. Objective.

The objective of this presentation is to present information on the acquisition of water related data by the BLM district offices for use in watershed analysis and management decisions. To this end, I will discuss various types of data that a manager may require; secondly, how to determine what data is available for your area. Thirdly, how to obtain that data and lastly, give a list of names and addresses as contact points for further information about any of the items presented.

II. Data Elements.

Water data may be divided up into roughly two categories. The first one is simply raw data while the second category is derived data. Derived data is usually defined as data such as evaportransporation and various types of indices such as forage production or fire danger which attempt to provide a number from which a management decision can be made. Raw data is data with which we are most familiar such as air temperatures, streamflow, etc and is the type of data discussed here.

III. Determining Availability of Data.

Data are available from many different agencies. These agencies can be broken down into two types: The Federal agencies and State agencies.

A. Federal Agencies.

There are three types of searches that can be made on Federal data bases. These are: a) searches of indexes to determine what is available by river basin or political subdivision. b) a library search to determine the availability of reports and c) searches for the data items themselves.

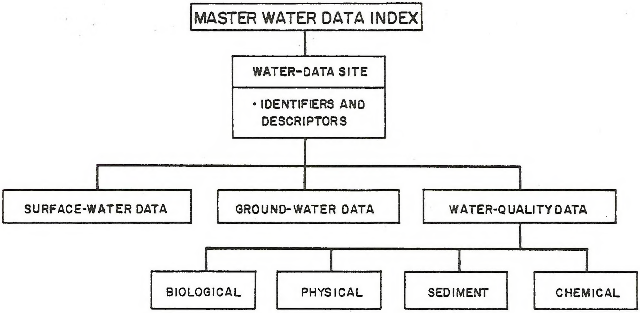
The following discussion is somewhat general in that I am assuming that you know what you want. Sometimes this in itself is quite a problem trying to determine exactly what types of data are required.

1. NAWDEX

By far the most comprehensive index available is called NAWDEX, the National Water Data Exchange. NAWDEX does not exchange data but is a system for keeping track of who has what data. All Federal agencies are required to index the water data they have with NAWDEX. NAWDEX indexes all water data collected by the U. S. Geological Survey, Forest Service, EPA, BLM, Corps. of Engineers, Bonneville Power etc.

They maintain a system of assistance centers where you can determine what data is available for any area. In the Pacific Northwest, these offices are all Geological Survey district offices. These names and addresses to contact are all given in the final section of this paper.

NAWDEX will give you back quite a bit of information about the stations retrieved in the search (see attached sheet). This includes all types of water ata. These water data are now listed according to the hydrologic unit code developed by the Office of Water Data Coordination rather than the old OWDC Map Number. Data obtained from a search includes the agency, station number, and name, location, state, county, and the type of data available (surface water, groundwater, reservoir or lake station). Also given is the period of



Block diagram of Master Water Data Index in NAWDEX.

record, drainage area, and then types of data as to whether or not it is stage, flow, or volume, how it is stored, the availability of the data. For stations which have water quality data available for either surface or groundwater sites, the index will indicate as to whether these are physical data such as temperature, Ph etc., chemical data, including hardness, nitrogen, radioactivity, etc. and biologic data, including bacteriological information. Sediment is also included as a water quality parameter. Information is given as to whether there is bedload or suspended sediments, particle size analyses etc.

This is by far the most comprehensive index available and should always be the first data base searched whenever trying to determine the availability of data. This is because all of the major data bases are indexed here, with the exception of the climatic data stored at the National Climatic Center in Asheville, N.C. Most states also include their information in NAWDEX, therefore, you will probably pick up anywhere from 70 to 90 percent of the water-related information available in a search of NAWDEX.

2. National Climatic Center, EDIS, NOAA

Climatic data can be obtained from the National Climatic Center, Asheville, N.C. The contact phone numbers are given in the last section of this report. The National Climatic Center indexes and stores all types of climatic data. This includes a wide range of satellite information as well as the conventional climatic data collected either by the National Weather Service or other agencies which choose to allow NCC to store their data. NCC can supply you with indexes listing types of data and their formats, period of record, etc. Just about the only way to determine all the information available is to call or write to NCC or contact the State Climatologist for your state. Under most circumstances and for many types of data, you can obtain them faster from the State Climatologist than you can by going through NCC.

3. Forest Service

Another federal agency with a large data collection network is the Forest Service. The Forest Service has many forest headquarters each of which maintains some type of data collection network. These data usually are restricted to precipitation, temperatures, in some cases wind, water quality data. The best way to determine the availability of this data is to contact the forest hydrologist in the given area. The only comprehensive index of Forest Service data collection networks that I have found has come from Missoula. But they admit that it is at best incomplete. Each forest has its network because each forest is relatively unique and must obtain data in whatever manner they feel is appropriate for them.

A very large data base that is used throughout the summer is the fire weather network. These data are available every day on what might be called a real time basis to anyone that has a computer terminal. These data can be called up from the USDA computer in Fort Collins. Each month these data are stored and put onto a tape and then at the end of the year the data are entered into the Forest Service data base which includes other types of data as well as just the fire weather data. One disadvantage of the fire weather data base is that it is not continuous. That is, the data are taken once per day and the stations are operated only during the summer months. There is a movement now towards trying to maintain some of these stations on a year-round basis to provide more long term weather data. These continuous stations however are few and far between at the present time. To determine the availability of information within this data base, contact the Forest Service in Fort Collins.

4. WRSIC

There are several places where you can do a literature search to determine what types of studies have already been done in your area. The national data base for this is called WRSIC (Water Resources Scientific Information Center). The data base for this is the publication, Selected Water Resources Abstracts, published by WRSIC which includes data indexed by various centers established around the country by the Office of Water Research and Technology in the Department of Interior. These are reports published by the State Water Resources Research Institutes or Centers and federal water resources related agencies. All Federal agencies have some type of contact with WRSIC. For non-Federal people, in this area, the first contact point should always be the Water Resources Research Center in their state. They can either do the search or can give you the address as to where it can be done. Each Federal agency normally includes their publications within this data base which consists entirely of citations and abstracts. From these abstracts a person can normally tell whether or not you are interested in that publication. Information on Forest Service publications which may not be cataloged within WRSIC can be obtained from the Forest Service Regional Headquarters in Missoula, Fort Collins, Ogden or Portland. Each one of these circulates lists of new publications.

Publications which are very hard to locate since they are basically in-house publications are those of agencies such as Bureau of Indian Affairs and Bureau of Land Management. Often times circulation of documents by these agencies is rather restricted and unless you are either in the agency or within the area that the agency decides circulation is justified, we find out about them purely by accident.

A rather extensive literature search is not always justified. There are many times when the study is going to be just a small one for a very local purpose. If it is going to be a rather large project, however, an extensive literature search is easy to justify and that one publication which has some information that you require could save you a tremendous amount of money and time.

B. State Agencies

There are many state agencies which collect, catalog, archive and disseminate information about water and climate in a given state. The names vary from state to state and you must be familiar with that state before you can find some of this information. The following general headings are given to help you get started in your search for information.

1. State Climatologists

The State Climatologist in each one of the states should be your first contact point for any type of weather information. If you contact the National Weather Service office in each state, they will probably refer you to the SC anyway. The SC is also a good contact for finding out what types of information are available from the National Climatic Center. In some states, the State Climatologist also handles the dissemination of streamflow and other water-related data, as well as climatic data. Names and addresses are given in the last section of this report.

2. Water Resources Research Institute or Centers

Each state has established a water resources research institute or center at the land-grant university in that state. Many small studies are done which do not obtain a very wide circulation. Each one of the centers also contains some type of library which can help you in determining the information available from state reports, particularly those studies done by the institutes themselves or people related to the institutes.

3. Colleges of Agriculture

Each state university also has a College of Agriculture. This college will do many different types of research but included in their services will be the search of the Department of Agriculture data base of ongoing studies as well as completed studies and a set of publications from the Agricultural Experiment station of that state which reports the results of research done in that state by the College. In addition, they usually also maintain a list of scientific publications by members of the college. Since these are state oriented publications in most cases, they are normally quite specific with application to areas within those states or at least the region. It is often possible to obtain data or information from the Colleges of Agriculture that can be obtained in no other manner. This is particularly true of soils information.

4. State Department of Land or Equivalent

Each state has a certain amount of public land within it. There must be a state agency to administer this land. These agencies range all the way from a caretaker agency where they really do not much more than maintain an inventory and lease out the land to agencies which maintain active programs of research and management and have rather large staffs. In general these agencies do not collect much data at all and what they have is normally going to be quite sparse.

5. Fish and Game Departments

Fish and Game Departments are very concerned with water quality and maintain networks usually of at least water temperature and Ph information. This data is going to be quite scattered and of uncertain quality in many cases. However, there is often a large amount of it, and since it is often taken in areas which are quite remote, can be a great help in trying to get an idea as to the general water quality characteristics of an area.

6. Departments of Water Resources

Each state, in addition to the State Department of Lands, usually has a Department of Water Resources, Water Rights or of Natural Resources. Occasionally these are combined with the Department of Lands but particularly in western states, these are separate agencies since water presents its own unique problems as opposed to other resources. These agencies conduct a great number of studies as to the utilization of water resources and the application of water law. These agencies normally are working hand in hand with the U.S. Geological Survey in the collection of surface water and groundwater data. Thus most of the information which they use is collected by the Geological Survey and is often written up in joint reports. They will occasionally, however, sponsor studies by other agencies and the only way to find out about these is to contact the individual departments to determine what types of information are available.

IV. Available systems.

There are several types of water data storage and retrieval systems. Almost all of the federal systems are of the type where you normally go through some sort of contact rather than doing the search yourself, since some experience is usually required to find exactly what you want. Following is a short description of what National systems are available. These have been mentioned in the above descriptions but a little more detail is given here.

A. National Systems

Five Federal agencies maintain data systems which would be of interest to this audience. These are the USGS WATSTORE System, the EPA STORET system, the NOAA National Climatic Center, the Fire Weather Data Library, and the SCS Snow Survey data.

All information stored in the WATSTORE and STORET systems will be indexed in the NAWDEX index. Thus you can find out immediately by looking at your NAWDEX search as to what types of information you can obtain from the USGS and EPA.

1. EPA (STORET)

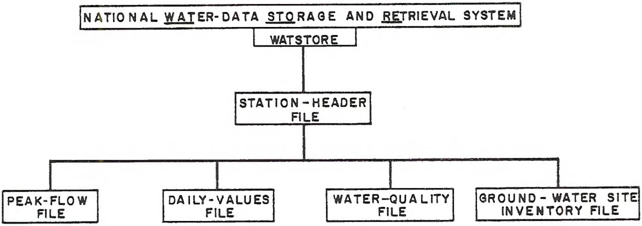
STORET is a system for storage and retrieval of data relating to the quality of water in the United States. STORET is the central depository of all water quality data collected by EPA as well as many other contributing agencies. The primary use of information within STORET has been for water quality assessment and for monitoring and surveillance programs. While the ability to store 1800 different water quality parameters is available, not nearly that many parameters are actually used very often. Around 20 or so parameters, most of which are included in EPA's list of water quality criteria, are the ones most often accessed. At the present time, most Federal and many State agencies have some sort of computer access to STORET. Since this is always changing it is quite difficult to determine exactly where to go to find out about your access point. Each Federal agency has its own type of protocol for accessing of Federal agency systems and thus you would have to go through your own agency to determine where to go. Anyone can access STORET through NAWDEX and may be the best way to go for anyone without some other easier to use access point. STORET has the capability of formatting data into a report ready form, do various types of statistical analyses and plot a wide variety of graphics. EPA can provide more complete information.

2. USGS (WATSTORE)

WATSTORE consists of four main files. This includes a peak flow file which contains the annual peak flow at all U. S. Geological Survey stations. Some modifications are presently being made to this file to include all peaks above a base for partial duration studies as they are published in the water resource data publication for each state. It will be some time before this is all finished. A daily value file is also included. This includes all parameters for which daily data are collected, including streamflow, groundwater levels, water quality data of any type, lake stations, reservoir contents etc. A third file is the water quality file. These are all water quality data which are collected at any USGS station whether it is surface water or groundwater or whether it is on a continuous or on an irregular basis. The final file is a groundwater site inventory file. This gives information about all the groundwater data collection sites such as geohydraulic characteristics, drilling information etc. The WATSTORE system includes a large number of application programs. By using their application programs you can generate specialized tables, plots, monthly and annual statistics and duration tables, low-flow, high-flow and frequency distribution, histograms and other tables. In addition WATSTORE uses the SAS package of statistical programs to do the wide range of statistical analyses. Thus if you have any type of statistical analysis that you wish done on data available from the USGS they can do it for you and save you quite a bit of work. In addition if you wish to have data at a local computer center, you can obtain the information from them on magnetic tape or punch cards.

3. National Climatic Center

The National Climatic Center, NOAA, has very many application programs. These are usually done for agency contracts. NCC is presently in somewhat a state of flux in that they are obtaining a new computer system. When this


NATIONAL WATER-DATA STORAGE AND RETRIEVAL SYSTEM
WATSTORE
STATION-HEADER FILE
PEAK-FLOW FILE
DAILY-VALUES FILE
WATER-QUALITY FILE
GROUND-WATER SITE INVENTORY FILE

computer system transition is completed, they will have on-line access to their data base for other Federal agencies as well as some state and private groups. At the present time, the best way to find out how to obtain data, reports and analyses is to call them up or contact your State Climatologist. Once they have completed the transition to the new computer system, sometime in 1981, all of this will be on-line and you will be able to query them as to application, programs, data and publication availability as well as transmit data or run their programs.

Data are available from NCC in a variety of formats including cards and magnetic tape. These are standard formats which they have developed over the years and are described in their publications. Depending upon your computer system it is best that you contact them first to determine the proper format to use since some of these formats are easier to use in some languages than in others. There are many inter-agency agreements with NCC in the supplying of data so some contact must be done within your agency in order to determine just how it is done. In most cases, however, a phone call to NCC with a purchase order number is all that is necessary.

4. Forest Service Fire Weather Library

The Forest Service maintains all of their fire weather data on a computer system in Fort Collins, Colorado. These data must be obtained from them. For any further hydrologic data, the individual forest headquarters must be contacted. A visit to their office is often required. It should be emphasized that much of the data collected by the individual forests is kept in that forest and not put into a national system. Only the fire weather information is routinely included in the computer system.

5. Soil Conservation Service Snow Survey (SNOTEL)

The SCS SNOTEL System is designed for obtaining real time snow water equivalent , air temperature and precipitation. Capabilities exist to add many more sensors as needs dictate. These data are telemetered to Portland via master polling stations in Boise and Ogden. Non-SCS users are allowed access to the data in Portland or at the Fort Collins Computer Center. Access can be either by remote terminal or magnetic tape. For further information, contact your State Snow Survey Supervisor or SNOTEL in Portland.

B. State Systems

At the present time only two states in this area have a computerized water related data base or have plans for one. Idaho has a complete hydrologic data base system called HISARS, Hydrologic Information Storage and Retrieval System, while Utah is in the process of developing such a data base system. The data system for Utah is based upon one developed in Texas. The University of Nevada-Las Vegas, at the Desert Research Institute, does have a system which stores mostly radio isotope related information. There is, however, some water information available from that system that may be of interest to watershed managers. At the present time I know of no system for storing water data in Oregon.

The following description is for the Idaho HISARS system since that is the only comprehensive system currently available. This system now contains the following information.

1. Daily streamflow
2. Peak flows
3. Maximum and minimum air temperatures
4. Stream temperatures
5. Pan evaporation
6. Snowfall data
7. Snow survey information
8. Reservoir contents or reservoir elevations

Also included are data programs and various statistical analyses including frequency analyses, extreme values, etc. In addition, files may be outputted onto magnetic tape for use at other facilities and also for input into various programs for a simulation or statistical analysis.

The integration of the snow survey information and the streamflow temperature files into HISARS is not yet complete. However, that data is available to anyone who requests it.

The Hydrologic Unit Codes adopted by the Office of Water Data Coordination are being added to HISARS. When this is completed, data retrieved can be made by using any of the four levels in the HUC's. Mapping capability is being added also so that maps of precipitation or combinations of variables can be plotted on the line printers. In addition to the information contained in HISARS weather data from all National Weather Service Class A stations in Idaho and Spokane, WA are available on magnetic tape.

Since HISARS is accessible directly by any user without having to go through somebody, an example is given here of use of HISARS to obtain an index and some streamflow data. Data or index information can be retrieved by basin, county, climatic region, elevation, latitude and longitude, drainage area or station number.

Sometime during the next 18 months the job control language may change because of a change in computer systems at the University of Idaho. It is hoped that at that time at least some of the accesses to HISARS could be made on an interactive basis so that a program will query you as to what you require and will then develop the proper cards to submit to the HISARS system. Thus you will not have to concern yourself with formatting which you must do at the present time. All that is required to use HISARS is that you have a valid account code at the University of Idaho computing center. Most data now stored in HISARS is for Idaho with some data for Wyoming (Snake Basin), Utah (Bear Basin), Nevada and Oregon (Snake Basin) and Washington (Snake and Upper Columbia Basin). There is no known limit as to the amount of data that can be handled except the size of the disk pack used to store data.

An example of an index search to find streamflow data available in Shoshone or Kootenai Counties is as follows:

```
//JHISARS     JOB    (AGRUNOFF,474-42-2039),'MYRON'
//ONE         EXEC     HISARS
//SYSIN       DD       *
ACCESS
ELEMENT       STREAMFLOW
COUNTY        SHOSHONE    KOOTENAI
LIST          INDEX
/*
```

The following cards produced the attached listing of streamflow data. Only the HISARS cards are shown here. The computer system control cards have been left off.

```
ACCESS
ELEMENT       STREAMFLOW
STATION       12414500
PERIOD        10/1952  to  9/1953
LIST          DAILY
```

One last example of a program to produce a minimum flow analysis table is given below:

```
ACCESS
ELEMENT       STREAMFLOW
STATION       12414500
PERIOD        4/1940  to  3/1971
PROCESS
MINIMUM    FLOW    ANALYSIS
      LENGTH  =   1,3,7,15,30,45,60
```

The user's guide to HISARS is available from either the Department of Agricultural Engineering or Agricultural Information at the University of Idaho. This system is maintained within the Department of Agricultural Engineering. For information about the files contact the State Climatologist in the Department of Agricultural Engineering. As with WATSTORE, SAS, Statistical Analysis System, is available at the University of Idaho and so many statistical analyses which are not available within HISARS can be done. Example of analyses which have been supplied within the past year to various people are regression analyses and correlation between streamflow, snowfall, etc. The cost of running HISARS is usually less than $5.

The system being implemented in Utah is a derivitive of the Texas Natural Resources Information System. This system is expected to be operational in stages over the next two years. The Water Research Lab at Utah State University is taking the lead in developing the file for the hydrologic or water related parameters while the State Climatologist is taking the lead developing files for climate related parameters. For further information on this system and availability as it becomes implemented contact the Director of the Water Lab or the State Climatologist.

C. A Comparison of Systems

From the standpoint of the user, the more convenient it is to obtain the data the better off you are. This may seem to be an obvious statement but it is not always put into practice. Thus the closer to the user and the more contact the user has with the data base, the easier it is to obtain the data. From this standpoint I would like to suggest that the following procedure be followed when trying to determine the availability of data and in obtaining data for a given area.

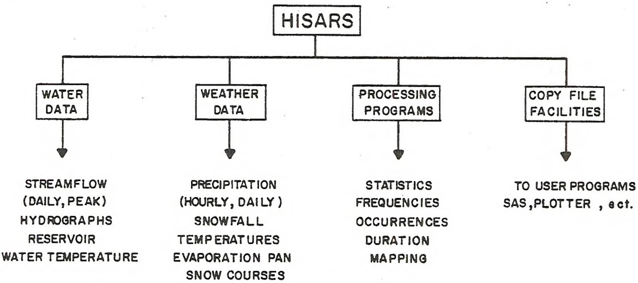
First of all, start at the local level. This means to contact everyone that you can think of within your state. First of all, your own agency, of course, then the State Climatologist or the Water Resources Research Institute at the land-grant university. Next should follow a search of NAWDEX, this being by far the most comprehensive index you will find.

In obtaining data for an area, first of all determine whether or not that data can be obtained on a local level. This means that in Idaho, for example, going to the Agricultural Engineering Department to obtain streamflow or weather data. In Utah you can go to the Water Lab or State Climatologist to obtain water and weather data. If they have it there, that is by far the best place to get it, simply because they are closer and probably have some familiarity with the area for which you need information. Finally, if you cannot obtain the information you require in any of these sources, then you should go to either the Geological Survey, National Climatic Center, or other agencies for the information.

If you have a computer terminal and the experience, it is best to do some of the searches yourself or have someone in your office do it for you. This is because the searches can be made quite personal. As an example, when using HISARS you can ask for an index of the parameters that you wish to determine exactly what data are available. Then by looking at the index it would be easy to go and find the exact information you want in either raw data or processed data. It should always be borne in mind that when working with large amounts of information on a computer terminal the least data transmitted the better. This means that if what you really want are nothing more than the extreme temperatures for an area, you should not transmit all of the maximum temperatures for a station. You should ask for an analysis of the records of that station so that the only thing actually calculated and printed out at the terminal are the extreme values. Large amounts of data should always be printed out at the computer center and mailed to you.

V. Conclusions.

In the future, the land manager is going to have tremendous computer capability available. These will include interactive systems in which the programs will query you as to exactly what information you want and then from your answers determine how to get it to you whether this is water-related, climate-related, land use or whatever. Graphics capabilities for doing graphical analysis, drawing maps etc. right at the terminal will be common as will a very wide range of simulation models for runoff, forage production, etc. The next five to ten years will see a tremendous change in the capabilities of watershed managers to arrive at intelligent and defendable decisions without going through many layers of bureauracy and trouble to effect these decisions. Computers and simulation programs are no panacea but with static or shrinking manpower coupled with greatly increasing demands upon the land, there is no question but that computers are going to play a large part in our future. Intelligent decisions can only be made when the maximum amount of information is available to the decision maker in a form useful to him. Computer systems of various types will make this data available more readily to the manager on the land.



VI. Names and addresses of contacts

NAWDEX

National Water Data Exchange
421 National Center
12201 Sunrise Valley Drive
Reston, VA 22092
(703) 860-6031
(FTS) 928-6031

WATSTORE

U. S. Geological Survey, WRD
Automatic Data Processing Unit
485 National Center
12201 Sunrise Valley Drive
Reston, VA 22092
(703) 860-7131
(FTS) 928-7131

WRSIC

Water Resources Center
Univ. of Wisconsin
215 N. Randall Ave.
Madison, WI 53706
(608) 262-3577

Idaho State Climatologist

Myron Molnau
Agricultural Engineering Dept.
University of Idaho
Moscow, ID 83843
(208) 885-6182

Nevada State Climatologist

Richard O. Gifford
Plant, Soil & Water Science Division
College of Agriculture
University of Nevada-Reno
Reno NV 89557
(702) 784-6947

STORET

STORET Users Assistance Group
Office of Hazardous Materials
Environmental Protection Agency
Washington, DC 20460
(202) 426-7792
(FTS) 426-7792

SNOTEL

Soil Conservation Service,USDA
Snow Survey
511 NW Broadway
Room 507, Federal Bldg.
Portland, OR 97204
(503) 221-2843
(FTS) 423-2843

Utah State Climatologist

Arlo Richardson
Utah Dept. of Agriculture
Dept. of Soils and Biometeorology
Utah State University
Logan, UT 84322
(801) 752-6216
(FTS) 586-7181

Oregon State Climatologist

W. Lawrence Gates, Director
Climatic Research Center
Oregon State University
Corvallis OR 97331
(503) 754-3714

National Climatic Center, NOAA

National Climatic Center, NOAA
Federal Bldg.
Asheville, NC 28801
(704) 258-2850 ext. 683

NAWDEX Assistance Centers and USGS District Offices

Idaho

U S Geological Survey
Water Resources Division
P. O. Box 036
Room 365, Federal Bldg.
550 W. Fort Street
Boise ID 83724
(208) 384-1750
(FTS) 554-1750

Utah

U S Geological Survey
Water Resources Division
8002 Federal Bldg.
125 South State Street
Salt Lake City, UT 84138
(801) 524-5654
(FTS) 588-5654

Oregon

U S Geological Survey
Water Resources Division
P. O. Box 3202
830 N. E. Holladay St.
Portland OR 97208
(503) 231-2021
(FTS) 429-2021

Nevada

U S Geological Survey
Water Resources Division
Room 227, Federal Bldg.
705 North Plaza Street
Carson City, NV 39701
(702) 882-1388
(FTS) 470-5911 ask for 882-1388

Fire Weather

Rocky Mountain Forest & Range Experiment Station
Forest Service, USDA
240 W. Prospect
Fort Collins, CO 80521

A guide to obtaining information from the USGS, 1978
Geological Survey Circular 777

Free from: Branch of Distribution
U. S. Geological Survey
1200 South Eads Street
Arlington VA 22202

Where to find weather and climatic data for forest research studies and management planning. USDA Forest Service General Technical Report NC-27.

Free from: North Central Forest Experiment Station
USDA , Forest Service
1992 Folwell Ave.
St. Paul, MN 55108

MAP NUMBER	MAP LETTER	OWDC NUMBER	AGENCY STATION NUMBER	STATION NAME	LATITUDE	LONGITUDE	STATE	COUNTY	SITE	PERIOD OF RECORD BEGAN	PERIOD OF RECORD DISCONTINUED	INTERRUPTED RECORD	STORAGE OF DATA PUBLISHED	STORAGE OF DATA NOT PUBLISHED	STORAGE OF DATA DATA ON PUNCHCARD	STORAGE OF DATA DATA ON MAG STOR DEVICE	STORAGE OF DATA OTHER
30	W	85299	00MA05CC0001	RED R AT EMERSON	490005	0971240	CN		STREAM	1960						*	
30	V	57136	ROS-121	ROSEAU R	484701	0954405	MN	135	STREAM	1967	1968		*				
30	V	75177	05105300	ROSEAU R BL ROSEAU MN	485328	0954350	MN	135	STREAM	1972			*			*	*
30	V	63287	05107500	ROSEAU R AT ROSS MINN	485437	0955518	MN	135	STREAM	1962	1969	*	*		*	*	
30	V	74992	05112000	ROSEAU R BL STATE D 51 NR CARIBOU M	485854	0962746	MN	069	STREAM	1972			*			*	
30	V	85298	00MA05CD0001	ROSEAU R AT GARDENTON	490515	0964115	CN		STREAM	1960						*	
30	V	57135	ROS-55	ROSEAU R	485852	0962655	MN	069	STREAM	1967	1968		*				
39	A	85302	00SA05NB0001	LONG C NR ESTEVAN	490540	1030125	CN		STREAM	1960						*	
39	A	73264	05113600	LONG C NR NOONAN ND	485852	1030434	ND	023	STREAM	1970				*			*
39	A	85303	00SA05NA0001	LONG C AT OUTRAM	4902	10327	CN		STREAM	1960						*	

OWDC NUMBER	TYPES OF DATA																																SUPPLEMENTARY DATA						AGENCY REPORTING
	PHYSICAL										CHEMICAL														BIOLOGIC			SEDIMENT											
	TEMPERATURE	SPECIFIC CONDUCTANCE	TURBIDITY	COLOR	ODOR	PH (FIELD)	PH (LAB)	EH	SUSPENDED SOLIDS	OTHER	DISSOLVED SOLIDS	CHLORIDE	NUTRIENTS (NITROGEN)	NUTRIENTS (PHOSPHORUS)	COMMON IONS	HARDNESS	RADIOCHEMICAL	DISSOLVED OXYGEN	OTHER GASES	MINOR ELEMENTS	PESTICIDES	DETERGENTS-MBAS	BIOCHEMICAL OXYGEN DEMAND	CARBON (TOTAL, DISSOLVED ETC.)	COLIFORMS	OTHER MICRO-ORGANISMS	OTHER	CONCENTRATION (SUSPENDED)	PARTICLE SIZE (SUSPENDED)	PARTICLE SIZE (BED MATERIAL)	OTHER	SURFACE WATER STATION	GROUND WATER STATION	WATER STAGE OR LEVEL	WATER DISCHARGE	TIME OF TRAVEL	DRAINAGE AREA	
85299	5	5	5	5			5					5			5	5				8																		WQ8
57136	5		5	5	5	5				5		5	5	5	5	5	5	5				5	5		5						5							L11
75177	5	5		5		5					5	5	5	5	5	5				5												*						GS
63287	5	7		7			7				7	7		7	7	7																*		*	*		*	GS
74992	5	5		5		5					5	5	5	5	5	5		5		5			5		5							*		*	*		*	GS
85298	5	5	5	5			5					5			5	5				8																		WQ8
57135	5		5	5	5	5				5		5	5	5	5	5	5	5				5	5		5						5							L11
85302	5	5	5	5			5					5			5	5				8																		WQ8
73264	5	5					8																									*		*	*		*	GS
85303	5	5	5	5			5					5			5	5				8																		WQ8

OWDC NUMBER	DRAINAGE AREA (SQUARE MILES)	TYPES OF FIELD MEASUREMENT				TYPES OF DATA																		AGENCY REPORTING
		STAGE																						
		FREQUENCY	RECORDED	TELEMETERED	DISCHARGE (FREQUENCY)	DAILY DISCHARGE	PEAK STAGE OR DISCHARGE	LOW FLOW	CROSS-SECTION	FLOW DURATION	FLOOD FREQUENCY	COEFFICIENT OF ROUGHNESS	QW RECURRING MEASUREMENT	QW NONRECURRING MEASUREMENT	TIME OF TRAVEL	FLOOD PLAIN MAPS	PRECIPITATION	TIDES	DATUM (MEAN SEA LEVEL)	SEDIMENTATION STUDIES	CONTENTS	SURFACE INFLOW-OUTFLOW	CHANGE CONTENTS/LEVEL	
30649		4	*																				*	L02
22636		4																						L02
A3798	123	3				*	*	*																GS
06114	482	1	*			*	*			*	*		*						*	*				GS
17646		1	*			*											*		*	*	*	*	*	CE
17647		1	*			*	*												*					CE
06116	1830	1	*			*	*				*		*						*					GS
22617		4																						L02
38196	120						*	*																GS
06242	56.70	2					*	*	*			*												GS

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         STREAMFLOW STATIONS


ST. JOE RIVER AT CALDER, IDA                                 SHOSHONE                   STATION NO.  12.4145.00
         LATITUDE  47-16-30        LONGITUDE  116-11-15      GEOGRAPHIC LOCATION BLOCK  4716-142-214
         ELEVATION           FT MSL     REGION   04          BASIN  14-/4         AREA    1030 SQ MI
                  PERIOD OF RECORDS     LENGTH, MONTHS
                  05/1911 - 09/1912             17
                  08/1920 - 09/1973            638

COEUR D'ALENE LAKE AT COEUR D'ALENE, IDA                     KOOTENAI                   STATION NO.  12.4155.00
         LATITUDE  47-39-55        LONGITUDE  116-46-05      GEOGRAPHIC LOCATION BLOCK  4716-324-142
         ELEVATION           FT MSL     REGION   01          BASIN  14-/4         AREA    3700 SQ MI
                  PERIOD OF RECORDS     LENGTH, MONTHS
                  08/1904 - 10/1905             15
                  01/1906 - 02/1906              2
                  04/1906 - 04/1906              1
                  06/1906 - 04/1911             59
                  06/1911 - 09/1917             76
                  11/1917 - 09/1922             59
                  11/1922 - 09/1962            479

HAYDEN CREEK BELOW NORTH FORK NEAR HAYDEN LAKE, IDA          KOOTENAI                   STATION NO.  12.4160.00
         LATITUDE  46-49-22        LONGITUDE  116-39-10      GEOGRAPHIC LOCATION BLOCK  4616-342-412
         ELEVATION  2370     FT MSL     REGION   01          BASIN  14            AREA      22 SQ MI
                  PERIOD OF RECORDS     LENGTH, MONTHS
                  10/1965 - 09/1973             96

RATHDRUM PRAIRIE CANAL AT HUETTER, IDA                       KOOTENAI                   STATION NO.  12.4180.00
         LATITUDE  47-42-35        LONGITUDE  116-52-05      GEOGRAPHIC LOCATION BLOCK  4716-324-323
         ELEVATION           FT MSL     REGION   01          BASIN  14            AREA         SQ MI
                  PERIOD OF RECORDS     LENGTH, MONTHS
                  10/1960 - 09/1973            156

SPOKANE RIVER NEAR POST FALLS, IDA                           KOOTENAI                   STATION NO.  12.4190.00
         LATITUDE  47-42-10        LONGITUDE  116-58-40      GEOGRAPHIC LOCATION BLOCK  4716-323-321
         ELEVATION           FT MSL     REGION   01          BASIN  14            AREA    3840 SQ MI
                  PERIOD OF RECORDS     LENGTH, MONTHS
                  01/1913 - 09/1973            729
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Streamflow index listing

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          ST. JOE RIVER AT CALDER, IDA                               SHOSHONE                                12.4145.00

                                                    MEAN DAILY STREAMFLOW IN CFS
1952-53
          OCTOBER   NOVEMBER   DECEMBER     JANUARY   FEBRUARY     MARCH       APRIL       MAY        JUNE         JULY    AUGUST  SEPTEMBER

  1       342.00     333.00     230.00      290.00    5270.00     890.00     2040.00    6500.00    8660.00     2830.00    728.00     494.00
  2       338.00     309.00     302.00      265.00    3940.00     798.00     1900.00    5460.00   10200.00     2720.00    702.00     515.00
  3       333.00     290.00     346.00      294.00    3370.00     798.00     1870.00    4850.00    8960.00     2660.00    709.00     531.00
  4       333.00     279.00     342.00      358.00    4210.00     798.00     1790.00    4890.00    7880.00     2590.00    819.00     499.00
  5       329.00     290.00     317.00      290.00    3300.00     770.00     1920.00    5940.00    7750.00     2470.00    722.00     484.00
  6       325.00     294.00     298.00      260.00    2670.00     735.00     2050.00    8200.00    7590.00     2360.00    670.00     474.00
  7       325.00     283.00     294.00      280.00    2470.00     716.00     1960.00   11000.00    7680.00     2250.00    634.00     459.00
  8       321.00     257.00     302.00      294.00    2550.00     763.00     1780.00    9440.00    7500.00     2160.00    670.00     449.00
  9       313.00     221.00     279.00      728.00    2250.00     928.00     1580.00    7570.00    6900.00     2100.00    702.00     435.00
 10       313.00     224.00     279.00     1190.00    1960.00    1210.00     1490.00    6160.00    6460.00     1970.00    658.00     435.00
 11       313.00     325.00     275.00     1090.00    1790.00    1390.00     1480.00    5310.00    6860.00     1850.00    599.00     430.00
 12       309.00     367.00     321.00     2770.00    1590.00    1430.00     1480.00    5030.00    7880.00     1770.00    559.00     426.00
 13       309.00     371.00     440.00     3290.00    1490.00    1340.00     1420.00    5180.00    8680.00     1680.00    537.00     411.00
 14       306.00     346.00     384.00     2010.00    1380.00    1240.00     1320.00    5730.00    7500.00     1600.00    499.00     393.00
 15       306.00     350.00     321.00     1340.00    1340.00    1210.00     1220.00    6630.00    6560.00     1530.00    499.00     389.00
 16       309.00     338.00     283.00     1130.00    1240.00    1240.00     1310.00    7570.00    5940.00     1440.00    499.00     376.00
 17       306.00     309.00     268.00     1230.00    1200.00    1310.00     1500.00    8800.00    5800.00     1340.00    499.00     367.00
 18       302.00     290.00     272.00     1800.00    1130.00    1200.00     1840.00    9410.00    5560.00     1270.00    504.00     371.00
 19       302.00     283.00     275.00     2610.00     990.00    1250.00     2100.00   10900.00    5090.00     1210.00    515.00     362.00
 20       302.00     283.00     272.00     2320.00     860.00    1270.00     2920.00   10900.00    4600.00     1160.00    521.00     371.00
 21       302.00     268.00     261.00     2340.00     930.00    1230.00     4570.00    8710.00    4160.00     1120.00    531.00     367.00
 22       298.00     208.00     261.00     1810.00     912.00    1170.00     6200.00    7130.00    3880.00     1060.00    526.00     362.00
 23       298.00     150.00     257.00     1890.00     868.00    1130.00     9650.00    6140.00    3740.00     1010.00    521.00     371.00
 24       298.00     208.00     217.00     2250.00     784.00    1170.00    10600.00    6260.00    3530.00      982.00    622.00     402.00
 25       294.00     230.00     160.00     1930.00     819.00    1720.00     9180.00    6220.00    3350.00      958.00    749.00     411.00
 26       294.00     140.00     210.00     1670.00     812.00    1910.00     8860.00    6580.00    3180.00      950.00    599.00     430.00
 27       294.00     100.00     260.00     1400.00     833.00    1840.00    10500.00    7500.00    3080.00      898.00    576.00     531.00
 28       290.00     120.00     280.00     1250.00     935.00    1920.00    12900.00    7680.00    2990.00      861.00    570.00     531.00
 29       287.00     130.00     298.00     1180.00               2020.00    10500.00    7900.00    2960.00      826.00    570.00     521.00
 30       313.00     180.00     317.00     1500.00               2170.00     8070.00    8390.00    2880.00      798.00    542.00     407.00
 31       354.00                317.00     2110.00               2210.00                8110.00                 763.00    510.00

TOTAL    9658.00    7776.00    8938.00    43169.00   51893.00   39776.00   126000.00  226090.00  177800.00    49186.00  18561.00   13004.00
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Streamflow file daily data listing

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ST. JOE RIVER AT CALDER, IDA                                    SHOSHONE           STATION NO.  12.4145.00

                                     LOW FLOW ANALYSIS FOR YEAR BEGINNING APRIL 1
                                              MEAN MINIMUM DISCHARGE
                                                       CFS
                                                LENGTH OF PERICD, DAYS
    YEAR          1          3          7         15         30         45         60
   1940-41     298.00     300.00     310.29     315.20     333.50     339.29     355.17
   1941-42     390.00     395.67     407.29     416.73     440.77     468.20     478.83
   1942-43     329.00     333.67     339.00     355.93     364.70     375.80     395.43
   1943-44     207.00     269.00     327.14     356.27     369.03     400.44     409.03
   1944-45     180.00     190.00     213.57     238.47     302.63     321.36     327.92
   1945-46     326.00     327.33     331.71     340.40     386.70     409.98     412.18
   1946-47     342.00     343.33     349.43     364.27     382.37     405.69     426.32
   1947-48     382.00     386.00     400.00     446.00     473.13     485.27     513.65
   1948-49     320.00     343.33     360.00     362.67     369.00     383.78     395.10
   1949-50     330.00     331.33     341.43     359.87     395.93     415.93     417.55
   1950-51     444.00     445.67     459.00     490.13     513.73     553.51     585.65
   1951-52     380.00     384.33     385.57     401.67     441.63     469.64     511.87
   1952-53     100.00     116.67     154.00     208.13     255.53     262.07     272.28
   1953-54     302.00     303.33     303.71     310.40     321.83     339.04     357.42
   1954-55     390.00     423.00     469.00     516.33     574.47     603.40     630.93
   1955-56     444.00     460.67     488.29     505.93     531.07     554.80     608.12
   1956-57     230.00     256.67     352.86     399.33     443.33     461.16     488.13
   1957-58     240.00     283.33     318.14     347.33     364.33     380.24     393.07
   1958-59     347.00     353.67     363.57     385.87     408.20     418.40     430.67
   1959-60     510.00     513.33     551.43     585.13     622.57     637.71     686.57
   1960-61     270.00     280.00     322.86     361.20     415.13     432.96     446.52
   1961-62     190.00     210.00     286.57     349.07     383.03     390.82     404.35
   1962-63     381.00     389.33     402.14     433.20     457.43     469.18     485.05
   1963-64     250.00     306.67     321.57     333.33     348.33     357.11     368.17
   1964-65     505.00     510.00     526.43     568.33     581.37     588.89     596.42
   1965-66     382.00     394.00     405.43     423.27     443.60     447.47     467.70
   1966-67     308.00     330.00     337.86     349.13     361.80     372.36     381.42
   1967-68     330.00     333.33     338.86     355.80     392.60     409.07     425.88
   1968-69     496.00     499.00     506.71     548.40     605.43     623.27     681.85
   1969-70     250.00     250.00     253.57     269.87     324.53     354.24     360.35
   1970-71     390.00     399.67     410.00     448.80     465.97     469.82     474.57

   M          2.49703    2.51874    2.54998    2.58169    2.61563    2.63309    2.65039
   S          0.14988    0.13380    0.11279    0.10234    0.09146    0.09016    0.09483
   G         -1.28905   -1.33432   -1.00511   -0.34304    0.15817    0.10405    0.23755
   Q 10        197.76     218.54     250.46     280.13     316.29     330.07     340.04
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Low flow analysis output

GREAT BASIN WATERSHED WORKSHOP
Summary of
Nevada Supplemental Guidance on Water Inventories
by Dick Jewell-NSO Hydrologist

Recent Federal directives state that water rights need to be secured in each state with public lands in the name of the United States. In order to accomplish this task, water inventories are needed to determine the water sources on public lands.

Nevada BLM currently has very little water information available and is about having to start from scratch in its water inventory efforts. To facilitate a coordinated water inventory program in Nevada, a 7211 Water Resources Inventory Manual Supplement has been prepared. Basically, the Supplement addresses the pre-field evaluation, field evaluation, water rights surveys, and water monitoring portions of the water resource inventory.

More specifically, the Nevada Supplement addresses purpose, objective, responsibility (of NSO and the Districts), methods of conducting the inventory, water rights filings, and water monitoring program followup. In addition to this, the Supplement includes a water resource inventory field form in the appendix (see attachment). The development of this form was a coordinated effort with various resources in the State in an attempt to gather all the basic water data needed. Wildlife, recreation, range, and minerals were among those resources providing input. Suggested approved inventory procedures are also discussed in the appendix. Current meter method, portable weir plates, portable parshall flumes, and calibrated container volumetric measurements are the procedural methods discussed.

In conclusion, the intent of the Nevada Water Resources Inventory Supplement was to provide Nevada with some guidance on conducting coordinated water inventories. The supplement is not complete when used for anything more than basic water resource inventories. Further manual guidance will be developed as other needs arise.

RECEIVED
9:00 A.M.
DEC 26
BUREAU OF LAND MANAGEMENT
IDAHO STATE OFFICE
BOISE, IDAHO

Nevada Water Resources Inventory

(1) Source #________________. (2) Source Name____________________.

(3) Observer________________. (4) Date__________. (5) County____________.

(6) District________________. (7) Resource Area____________________.

(8) Planning Unit______________. (9) Hydrologic Unit__________________.

(10) Location: T____R____Sec.____Subdivision__________. (11) Elevation_____.

(12) Land Status: BLM_____, Pvt_____, Other_____, If Pvt or Other - indicate_____.

(13) Water Source Type: well_____, spring_____, seep_____, pond______________,

lake _____, reservoir _____, catchment _____, stream or

river*_____, conveyance*_____, other ________________.

* If stream or conveyance/diversion - attach map.

(14) Water Status: perennial_________ intermittent_________.

(15) Water Quantity:

Quantity/Rate: cfs_____, gpm_____, acre feet_____.														
Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Average	
														Estimated
														Measured

If measured - method used________________________________.

undeveloped _____ developed _____ if developed - JDR# ______________.

(16) Water Quality Information Available: yes ___ no ___,

If available, where____.

(17) Water Properties: EC _____ Temp (F or C) _____ Turbidity ____________

DO _____ pH _____, Other ______________________.

(18) Use ____________________ (19) Water Right Status ______________.

(20) Access: foot ____ 4WD ___ 2WD ___. (21) Photo Taken: yes ___ no ___ If taken

where filed ______________.

(22) Remarks:

Element Definitions for Nevada Water Resource Inventory

(1)	Source #	Enter the number assigned this water source by each district.
(2)	Source Name	Enter the common name of this water source (i.e.: Mikes Spring, Humboldt River, etc.).
(3)	Observer	Enter observer's name.
(4)	Date	Enter date observed.
(5)	County	Identify by name and standard numerical code.
(6)	District	Identify by name and standard numerical code.
(7)	Resource Area	Identify by name and standard numerical code.
(8)	Planning Unit	Identify by name and standard numerical code.
(9)	Hydrologic Unit	Enter national watershed number as identified on the Hydrologic Unit Map for Nevada and enter the hydrologic area number assigned each basin by the State of Nevada. (i.e., 16060002/122)
(10)	Location	Legal description to the nearest ¼, ¼, ¼ Section.
(11)	Elevation	Enter elevation in feet above sea level as indicated on the USGS quad for the area.
(12)	Land Status	Indicate if BLM, private or other. If private or other indicate. (i.e.: State, Jones, etc.)
(13)	Water Source Type	Indicate appropriate source. If the source is a stream or conveyance, attach a map showing monitoring location and source route.
(14)	Water Status	Indicate whether the water source is perennial (have water year long) or intermittent (have water only part of the time).
(15)	Quantity/Rate	Indicate one of the following: cfs - cubic feet per second gpm - gallons per minute acre feet - one acre one foot deep. Measure the site when visited and estimate for the other months. Enter the quantity or rate in the appropriate monthly column and how the water source was quantified, estimated or measured. If measured, indicate the method used (i.e.: flow meter, measured bucket, etc.). Also indicate if the water source is developed or undeveloped and if developed list the JDR number for the project.

(16)	Water Quality	Indicate if water quality information is available and from where, (i.e.: REX, STORET, WATSTORE, Univ. Nevada, etc.)
(17)	Water Properties	EC - electrical conductivity reported in micromhos/cm. Temperature indicate in C or F. Turbidity reported in NTU. DO reported in mg/l. Other to allow additional parameter tests as needed.
(18)	Use	Indicate primary and secondary use of the water source (i.e.: municipal watershed/recreation or livestock/wildlife).
(19)	Water Right Status	Indicate if a water right for the water source is on record. If so, indicate who, when and number. If not, indicate if a filing for a right has been filed, by whom, when and number. (i.e.: Recorded Right, or Right Application - J. R. Brown - 6-17-79 - 36501).
(20)	Access	Indicate if access to the water source location is by foot, 4 WD or 2 WD vehicle.
(21)	Photo Taken	Enter yes or no--if taken enter where filed (i.e.: District photo file, District watershed photo file, etc.)
(22)	Remarks	Enter any additional information and reference item.

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Denver Service Center